

APPENDIX I

LANDSCAPE PESTS

CANKER *Cytospora* spp.

Cytospora canker is caused by different species of the fungus *Cytospora* spp. Which affect several species of trees, including aspen, Lombardy and other poplars, apple, cherry, peach, plum, birch, willow, honey locust, mountain ash, silver maple, spruce and Siberian elm. The fungus attacks stressed weak or injured trees. Trees affected by drought, insect pests, defoliation, sunscald, herbicides or mechanical injury are susceptible, especially trees with root damage.



***Cytospora* Canker**

trees. Oyster shell scale will also stress the tree. Increase plant vigor with proper water and fertilization. Remove all infected limbs during dry weather (make smooth cuts as near the trunk as possible). Disinfect pruning tools before and after pruning each branch in ethanol, Lysol or other disinfectant. Do not apply wound dressings, but allow the cleaned tissue to dry out. Remove loose bark.

Inspection: Symptoms are yellow or orange-brown to black discolored areas on the bark of the trunk or branches. Ooze is common. Cankers, sunken dead areas of bark with black pinhead-sized speckling or pimples may be present. With moist conditions, masses of spores will ooze out in orange coiled, thread-like spore tendrils.

Management: Plant canker resistant varieties. Prevent infection by preventing stress to trees. Drought and flooding are common stresses. Keep lawn mowers and string trimmers away from the base of

EASTERN TENT CATERPILLAR *Malacosoma americanum*



The eastern tent caterpillar is more a nuisance than a threat. While heavy infestations can cause serious defoliation, eastern tent caterpillars rarely kill trees except those already weakened by disease or climate and environmental stresses. Some studies indicate some defoliation strengthens trees and makes them hardier. These caterpillars get their name from the ugly tent-like nests that they spin in the crotches of host trees. They are native to North America east of the Rocky Mountains.

Eastern Tent Caterpillar

The preferred tree for these pests is the black cherry, but they will also infest other cherry trees as well as fruit trees such as apple and a variety of shade trees.

Eastern tent caterpillars are black and hairy with a white stripe and a series of blue dots along the length of the body. At maturity, they range from 5 – 7 cm (2 – 2 ½ in) in length. The moth is reddish in color with white bands on the forewings. Females can be double the size of the males with a wingspan of 7 cm (2 ½ in).

Eastern tent caterpillars survive the winter in masses of 100 to 300 eggs noticeable as shiny black bands encircling twigs. Eggs hatch in the spring at about the same time as the host tree comes into leaf. The young caterpillars then begin to consume leaves and spin the characteristic “tent” nest in the crotch of the tree. The nest continues to grow as long as the caterpillars keep feeding. When the caterpillars reach maturity, after about six weeks, they pupate in silken cocoons visible on trees, on the sides of buildings and on fences. Moths emerge in July to mate, lay eggs and then die.



E. Tent Caterpillar Eggs

MANAGEMENT



E. Tent Caterpillar Nest

Eastern tent caterpillar infestations rarely threaten the lives of trees, so management is generally for aesthetic purposes. Tents can be removed and destroyed at night after the caterpillars have returned from feeding.

During winter after leaves have dropped from host trees, search for the black bands of eggs encircling twigs. Physically remove the egg mass or prune it out of the tree and destroy them. If a treatment becomes necessary because of large numbers of “tents,” *Bacillus thuringiensis* Kurstaki is effective.

FOREST TENT CATERPILLAR *Malacosoma disstria*



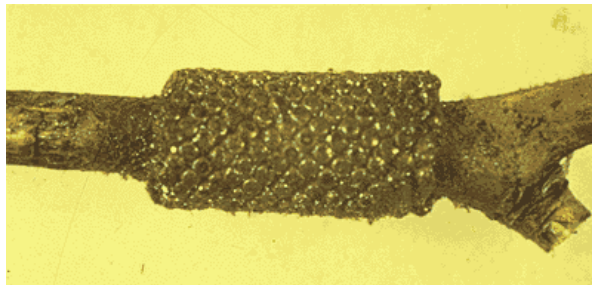
Forest Tent Caterpillar

A cousin of the eastern tent caterpillar, the forest tent caterpillar prefers hardwoods like sugar maples and oaks. The term “tent” caterpillar is a little misleading as these insects don’t construct large tent-nests in the crooks of trees. Instead they spin pad-like structures on trunks and on branches where they go to rest and to molt.

Other aspects of the forest tent caterpillar are similar to those of the eastern tent caterpillar. They may be ugly and unsightly, but their defoliation rarely kills host trees unless the trees are already diseased or under stress due to climatic or other

environmental factors. Forest tent caterpillars have a brownish body with bluish lines along the side. With each molt, a line of white, footprint-shaped spots becomes visible. Mature caterpillars can reach 5 cm (2 in) in length. Moths are yellowish-brown and chunky with two dark lines on the forewings.

Forest tent caterpillars start their lives as eggs laid in shiny brown bands of 100 to 300 around twigs. Caterpillars emerge as new leaves begin to appear and begin feeding and constructing their nests immediately. During the five or six weeks of the caterpillar stage, they go through four molts. After the last molt, the caterpillars spin yellowish cocoons in some sheltered place in which the final transformation to moth takes place. Moths emerge from the cocoons after about 10 days to mate, lay eggs and then die.



Forest Tent Caterpillar Egg Mass

MANAGEMENT



Forest Tent Caterpillar Adult

If populations are large and widely distributed, the biological insecticide *Bacillus thuringiensis* Kurstaki is effective for forest tent caterpillars. The pad-like tents can be collected and destroyed at night when the caterpillars return. Egg bands can be pruned out or removed in winter when leaves have fallen (the bands become more visible).

GYPSY MOTH



Gypsy Moth Caterpillar

Gypsy moth is a recent addition to the long list of insects that defoliate oak, aspen and other hardwood species in the United States. This exotic pest did not occur in North America until it was accidentally introduced into Massachusetts in 1869. Since then, gypsy moth populations have spread west and south.

Gypsy moth outbreaks can last one to five years. Outbreak populations then decline because of the buildup of disease, natural enemies and starvation. Low gypsy moth populations may be held in check by birds, insect predators and small mammals before

the next outbreak occurs. In oak-dominated stands, gypsy moth outbreaks usually persist two to five years before collapsing. Populations then remain low for four to 12 years before increasing again. Outbreaks may build and decline faster in aspen dominated stands than in oak stands.

Effects of gypsy moth defoliation are usually most severe during the initial outbreak in a newly infested area. If more than 60% of the canopy is consumed by gypsy moth caterpillars, trees typically “refoliate,” producing a second flush of leaves later in summer.

The amount of tree mortality and top kill sustained during a gypsy moth outbreak depends on the severity and frequency of defoliation and on tree health. Vigorous trees can often withstand severe defoliation for a few years. However, each refoilation stresses the tree, reducing its energy reserves. Subsequent stress, including additional defoliation, drought or frost injury, may kill the tree. Suppressed, diseased or low-vigor trees may be killed after one year of heavy defoliation. Severe gypsy moth defoliation, accompanied by an abundance of large hairy caterpillars and frass (fecal pellets), can be unsightly and may reduce the enjoyment of visitors at recreational areas.



Gypsy Moth Egg Mass with Hatching Larvae

Gypsy moth defoliation is primarily based on tree species composition. Stands dominated by oaks, aspen, birch, basswood, willow or other species preferred by gypsy moth will be at high risk of defoliation. Defoliation will be lower in stands dominated by tree species that are less preferred by gypsy moth, such as maples, ash and most conifers. Defoliation may also be higher where many dead branches, bark flaps and stem wounds are present because these areas provide good hiding places for gypsy moth caterpillars and pupae.

Stand hazard is increased by factors that reduce stand vigor such as overmature trees, suppressed or diseased trees, compacted soil or severe competition. Hazard also increases when drought, late spring frosts, flooding or other stressful environmental conditions occur. Tree mortality has been observed primarily in oak-dominated stands where gypsy moth defoliation coincided with drought or late spring frosts.

MANAGEMENT OPTIONS

Appropriate strategies for gypsy moth management depend on the specific management objectives for each stand, and the quality of the site.

Release of the parasite (*Cotesia melanoscelus*) on gypsy moth larvae may be useful in reducing the population and thus reduce defoliation.

Remove suppressed and low-vigor trees that will be highly vulnerable to damage by gypsy moth and other pests. Leave healthy trees with large crowns that are likely to survive defoliation. Residual trees will require one to two years to recover from defoliation, drought or other stress and adjust to increased exposure.

Thinning to reduce stand density can increase vigor of residual trees and reduce stand risk and hazard. Thinning is most appropriate on medium- and high-quality sites, where costs are economically justified.

To reduce stand hazard, cut suppressed, wounded, diseased or low-vigor trees with poor canopies. Thin to levels appropriate for the species and the quality of the site. Prevent soil compaction, wounds and other injuries to residual trees. Anything that reduces vigor of the residual trees can increase stand hazard.

Selecting against tree species that are preferred hosts of gypsy moth will reduce long-term risk of defoliation. On fertile, mesic sites, altering the species mix can result in stands of high-quality hardwoods. Favoring ash, tulip poplar, maples or conifers in northern or mixed hardwood stands can help increase stand diversity while reducing the risk of defoliation. Increasing species diversity within stands may also reduce the long-term risks of damage by other forest pests.

High-value oak-dominated stands approaching economic or pathological rotation age can be protected with an aerial application of Bt (*Bacillus thuringiensis* var. *kurstaki*), a short-lived microbial insecticide that causes a bacterial disease in foliage-feeding caterpillars. Bt is not toxic to other insects or to fish, birds, humans or other animals. An alternative pesticide for killing gypsy moth larvae is Dimilin (diflubenzuron) as an aerial application. It is applied at 1.7 g (0.06 oz). per acre and is effective. Other effective materials are Gypchek (gypsy moth nucleopolyhedrosis virus, NPV) and disparlure (Disrupt II) pheromone. The naturally occurring fungus *Entomophaga maimaiga* has also managed large gypsy moth populations in the environment.

Sometimes taking no action is the best alternative. Young, vigorously growing stands are likely to tolerate even severe defoliation for two to three years or longer. Stands with a mixture of species are less likely to sustain severe, repeated defoliation than are stands of nearly pure oak or

aspen. No action may also be the best option when stands are at or near optimal levels, especially if vigorous non-host species are present.

Managing stands to provide wildlife habitat may result in greater numbers of natural enemies that feed on gypsy moth. Understory plants and shrubs, trees with cavities and fallen trees are important for maintaining populations of predatory and parasitic insects, insectivorous birds, rodents and other small mammals. When leaving trees for wildlife, select species that are not preferred by gypsy moth.

Avoid using Bt to protect foliage in stands managed primarily for wildlife. Bt can kill caterpillars of “non-target” butterfly and moth species that are present during spraying. However, high gypsy moth populations may also temporarily reduce diversity and abundance of some native insect species.

Recreational areas experiencing a gypsy moth outbreak can be unpleasant places for camping or picnics. The swarms of large caterpillars and frass are distasteful, and the hair on the caterpillars may trigger allergic reactions in some people.

Use burlap, sticky or Teflon-coated bands on the lower trunk of gypsy moth host trees in recreation areas. Use burlap and sticky bands to trap or destroy caterpillars as they move up and down tree stems. Use Teflon-coated bands to prevent caterpillars from crawling up into tree canopies to feed. Banding is economically viable for high-value ornamental or shade trees. Where practical, water defoliated trees during warm dry periods. Prevent soil compaction and wounds to gypsy moth host trees.

HEMLOCK WOOLLY ADELGID (*Adelges tsugae* Annand)



A. tsugae is a small .03 cm (1/32 in) reddish-purple (aphid-like) insect that covers itself with a white fluffy secretion. *A. tsugae* was probably imported from Asia. The nymphs and adults have thread-like mouth parts (stylet) used to suck sap from young hemlock twigs. The needles may drop prematurely and defoliate the tree, resulting in death within several years. The adelgid may also inject a toxic saliva that disrupts the tree's growth hormones.

Hemlock Woolly Adelgid

Female adult *A. tsugae* lay eggs hidden by the white fluffy secretion, protecting them from many pesticides. The eggs hatch and the adelgid crawlers move about and settle to feed on twigs or the base of needles. The white, fluffy wool secretion soon covers them completely. The female adelgid overwinters within the mass and may begin to lay eggs in February. Some nymphs may develop into a winged adult which then may fly to another hemlock to lay eggs or to an alternate host such as spruce. Dispersion is by wind, birds and mammals.

MANAGEMENT

A second generation may develop in early fall and over winter, which can be time to attempt management sprays with insecticidal soaps and horticultural oils. This combination reduces the adelgid population and has minimal effects on natural predators and parasites. Horticultural oils may damage hemlock during growing season. Specimen trees may require a soil drench with Merit™ (Imidicloprid) which is taken up by the tree roots and translocated throughout the branches and leaves to kill the adelgid. Predators or parasites that are effective are not yet available.

More information may be obtained at the USDA Forest Service, northeastern area (610-975-4186).

NEEDLECAST *Rhizosphaera kalkhoffii*

Needlecast infects conifers, especially blue spruce, in nurseries, tree plantations and landscapes. Trees severely infected with this fungus may hold only the current year's needles (normal needle retention is five to seven years). *Rhizosphaera* infects needles on lower branches and progresses up the tree. Lower branches may be killed by the fungus. Moisture, shade and temperature near the ground appear to provide conditions favorable to the fungus.



Needlecast (*Rhizosphaera kalkhoffii*)

Needles on new growth become infected in late spring (May – June) although symptoms may not show up until late fall or the next spring. Infected needles turn purple to brown and drop from the tree.

Inspection: Check needles in spring (use a hand lens) looking for tiny fruiting bodies of the fungus protruding through the stomata of infected needles. Infected stomata appear as fuzzy black spots instead of their healthy white color. During wet weather, spores are released and splashed onto developing needles where infection occurs.

Management: Reduce environmental stress for the trees. Provide adequate water to the trees with root flood irrigation (not sprinklers) and improve aeration of the soil for moisture penetration. Most conifers are healthier in light soils that are not compacted. Plant healthy specimens in the proper location for the species. Do not shear (prune) trees when foliage is wet (such as in early mornings with dew). Pruning tools should be sterilized with denatured alcohol (three to five minutes) before and after use. If a fungicide treatment is required, treat when needles are half elongated in spring. Check the label for this fungus before purchase and follow label directions.

PINE NEEDLE SCALE *Rhizosphaera kalkhoffii*

The pine needle scale may be the most common armored scale found on conifers in the U.S. The white oyster shell-shaped scales can cover needles causing discoloration of needles and branch death. Heavy infestations suck large amounts of plant juices causing yellowed needles. Such heavy infestations cause twigs and branches to die. The nymph settles on needles, inserts its hair-like mouthparts and forms its new armor; white, oyster shell-shaped wax cover. The armor is about .15 – .3 cm (1/16 – 1/8 in) long fully grown, with a yellow spot on the small end. Male scales are smaller and more slender.



Pine Needle Scale

Pine needle scale overwinters as red-colored eggs protected under the female's old armor. Eggs hatch in mid-May into tiny flat nymphs (crawlers). The crawlers move to other parts of the tree to find fresh needles to feed on. The crawlers may be blown or brushed onto nearby trees. The nymphs increase in size for a few weeks. The males molt into a pre-pupa for a week before emerging as a winged adult. The females molt into wingless nymph-like adults. After mating, females continue to grow for a few weeks. She lays about 40 eggs. The second generation eggs hatch in late July over a two to three week period.

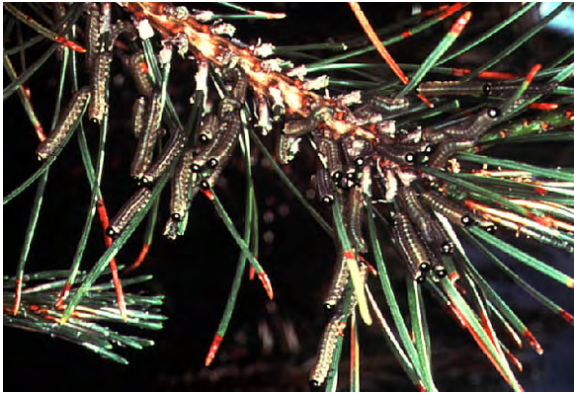


Twice-stabbed Lady Beetle

Inspection: Check needles for yellowing and the presence of oyster shell scale on needles early in the spring. Early detection may reduce spread and the need for sprays.

Management: Healthy conifers are more resistant to scale attack. Provide proper water and nutrients for tree health. The release of the predator, *Chilocorus stigma* (Say), the twice-stabbed lady beetle, will feed on the adult and nymphal scales. The use of insecticides will kill the predators and parasites and are not recommended. Scale predators and parasites are available from commercial insectaries.

PINE SAWFLY *Neodiprion sertifer* (Geoffroy)



European Pine Sawfly

The European pine sawfly was accidentally introduced from Europe and is found in the northeastern U.S. west to Illinois and up into Canada. It feeds on red, scotch, Jack, Japanese and shortleaf pine; and occasionally on other pines. The European pine sawfly is a primitive (non-stinging) wasp with a modified ovipositor that acts like a saw to make incisions into pine needles to insert eggs. The winter is spent as an egg inserted along the edge of host pine needles. The first instar larvae can only eat the surface of the pine needle, causing needles to turn brown and wilt. The larvae remain together feeding from needle tip to the base on

old needles. The larvae do not feed on new growth needles. Usually only one generation occurs. The eggs hatch from April through mid-May and larvae feed until mid-June growing to about 2.54 cm (1 in) long. Mature larvae drop to the ground and spin tough brown cocoons in the leaf litter. Adults emerge August through September to mate and lay eggs.

Inspection: Check pine needles in late winter for egg scars, then check for larvae and their damage in late April and early May. The larvae are grayish-green with a light stripe down the back, and a light stripe along each side followed by a dark green stripe. They feed in groups. If needles containing eggs are found, the needles can be pulled off and destroyed.

Management: Maintain pines in healthy condition through proper watering and nutrition. Colonies of larvae can be removed by cutting off the affected branch, or by knocking off the larvae into a bucket of soapy water with a sharp blow to the branch. Several parasites have been introduced that prey on this pest. Sawfly baculoviruses have been introduced, and are very effective in managing the pine sawfly. The virus Neochek-S was used by USDA Forest Service until 1971. It is being produced and used in Canada and England. The parasite *Trichogramma minutum* may be useful on sawfly eggs. The nematode *Steinernema kraussei* may be effective on diapausing sawfly in the forest leaf litter. Summer oils and insecticidal soaps can work well when applied as larvae are small and thorough coverage of the colony is accomplished.

SPRUCE SPIDER MITE *Oligonychus ununguis* (Jacobi)

The spruce spider mite feeds on all spruce, arborvitae, juniper, hemlock, pine, Douglas fir, Siberian larch and other conifers. Webbing produced by the mite as they feed may be present. Damaged needles on spruce will turn brown. The mite occurs on landscape conifers as well as in natural forests. Eggs are laid under bud scales, the axils of needles, or under webbing on the stem or branches.

Overwintering eggs are produced from September through November. The overwintering eggs hatch in April and May. The larvae and nymphs take about three and six days respectively to develop. The adult is about .5 mm

(.02 in) long. Color varies from dark green to dark brown. There are three or more generations that develop each year. Successive generations are produced at two to three week intervals. All active forms feed on preferred older needles. This small mite is easily dispersed by wind and is primarily a major problem in the spring and fall. Hot, dry summer weather causes a decline in the population and a reduction in feeding damage. Spruce spider mite feeding destroys the chlorophyll-bearing cells at the surface of the needle which results in flecking, stippling or bleaching of the foliage. Some needles may turn brown and drop as a result of the mite injury.



Spruce Spider Mite

Monitoring: Use a white sheet of paper beneath a branch or foliage and shake or rap the branch sharply. The tiny green to brown “dust particles” slowly moving on the paper are the mites. Extensive feeding on needles by mites will show by a change in color noticeable from a short distance. Early monitoring for each generation will provide information on mite population and damage.

Management: Provide proper watering and nutrients to enhance tree health. Reduce other causes of stress on trees. Do NOT use an insecticide as it will kill predators and parasites that are feeding on the mites. Purchase and release predatory mites that feed on spruce spider mites to reduce plant damage. Several species of predatory mites feed on spider mites: *Galendromus occidentalis*, *Mesoseiulus longipes*, *Neoseiulus californicus*, *Neoseiulus fallacies*, *Phytoseiulus macropillis*, and *Phytoseiulus persimillis*. These are available from IPM Laboratories, Inc. in Locke, New York (see Vendor Appendix). Other insect predators may also feed on spider mites. A relatively low-risk miticide that may be labeled for spruce spider mite is Spinosad.

SUDDEN OAK DEATH *Phytophthora ramorum*



In California *Phytophthora ramorum* causes crown symptoms and tree mortality.

Sudden oak death (SOD) was first reported in 1995 in California. Since then, thousands of tan oaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*), and California black oaks (*Quercus kelloggii*) have been killed by this fungus. On these hosts the fungus causes sudden simultaneous leaf death on a major stem or an entire tree. The leaf death may occur a year or more after the initial infection by the pathogen.

Early symptoms in oak are dark, hardened sap exuding from the main trunk, usually up to 1.83 m (6 ft) above ground. The seeping is the outside appearance of the underlying diseased portion of the tree and may result from the tree being girdled by the fungus. Other hosts to the fungus are Rhododendron, huckleberry, madrone, manzanita, bay laurel, buckeye and big leaf maple. Seeping has not been noted on the non-oak hosts. There are many species of *Phytophthora* that are transmitted by wind, rain and water splash moving viable spores to susceptible plants.

Oak wilt, *Ceratocystis fagacearum*, is an aggressive fungus disease of oak in the eastern United States which kills thousands of oak trees in forests and landscapes. Oak decline is a slow-acting disease complex that can kill oaks in eastern hardwood forests. These diseases have similarities to and may be confused with SOD.

Monitoring: Observations of susceptible plants for signs of declining health may be early indications of SOD. Check for cankers and seeping sap from the trunk or branches. Appearance of dead or dying leaves may be another symptom. The infection appears to spread within susceptible plants very rapidly once inoculated. Multiple independent cankers may be common.

Management: There are currently no known cures for sudden oak death. Spores for other *Phytophthora* species are known to survive in soils for years and can be moved by animals, vehicles and human activity inadvertently. Preventing the movement of plant material may slow the spread. Movement of infected host plants (and soil) through the nursery trade is a major concern. USDA APHIS is requiring nurseries in California, Oregon and Washington to be inspected, tested and certified before they can ship plant material out of state.



Oak wilt quickly kills most infected trees. Wilting leaves turn brown at the margins (inset) and fall as the tree dies.

WHITE PINE BLISTER RUST *Cronartium ribicola*



White Pine Blister Rust

White pine blister rust may be the most destructive disease of five-needle (white) pines in North America. Important white pine hosts are eastern white pine (*Pinus strobes* L.), western white pine (*Pinus monticola* Dougl.), or sugar pine (*Pinus lambertiana* Dougl.). The rust fungus cannot spread from pine to pine, but requires an alternate host, *Ribes* sp. (currants and gooseberries) to complete the cycle. Establishment of pure pine stands is no longer possible. A project to select and improve blister rust-resistant white pines may become the means to manage the disease.

The early symptom of blister rust is a yellow or red spot on needles soon after infection occurs, but this is indistinct and easily overlooked. The next symptom is a slight swelling of the infected branch which becomes a spindle-shaped canker. After one or two years the fungus produces spores from the canker which will completely girdle the branch or bole of the tree and kill it. The needles become red to form a blister rust flag. The bark around the margins of the canker turns a distinct orange color.

Infection of pine occurs in late summer by basidiospores produced from teliospores on *Ribes* sp. leaves. Basidiospore germ tubes enter needle stomata and the fungus grows into the branches forming a blister rust canker. Cool, moist conditions favor the basidiospore survival, germination and entry into pines. Pycnia (spermogonia) form at the margin of the canker and pycniospores (spermatia) are produced over the following year or two. Pycniospores fertilize receptive hyphae, resulting in mycelium that produces dikaryotic aeciospores the following year. Aecia erupt through the bark as white blisters. The blister erupts to release masses of yellow-orange aeciospores, which are wind-borne to infect the alternate hosts (*Ribes* sp.). Within a few weeks, uredinal pustules develop on the lower surface of *Ribes* leaves, which spread to other *Ribes*. Hair-shaped telial columns emerge from uredinal pustules. Teliospores form into basidiospores to infect white pines.

Monitoring: Inspect the general area for the alternate *Ribes* species (currants or gooseberries). Check white pine for swollen branches indicating canker formation.

Management: There are no known chemicals for treating or preventing white pine blister rust. Remove weeds to improve air circulation. Remove understory branches to 1.83 m (6 ft) high from the white pine trees. Find and prune out branches that show early stages (swelling) of canker formation. Eliminate all *Ribes* sp. in the area. Provide proper water and nutrients to promote white pine health.

WHITE PINE WEEVIL *Pissodes strobi* (Peck)



White Pine Weevil Adults

The white pine weevil is a native insect that attacks eastern white pine. The Sitka spruce weevil and Engleman spruce weevil should also be classified as *Pissodes strobi*. Eastern white pine is the most suitable host for brood development, however, the white pine weevil may attack 20 different tree species including ornamentals. Trees severely attacked by white pine weevil are eastern white pine (*Pinus strobus* L.), Jack pine (*Pinus banksiana* Lamp.), Norway spruce (*Picea abies* L.); and commonly attacked are foxtail pine (*Pinus balfouriana* Grev. & Balf.), Japanese pine (*Pinus densiflora* Sieb. & Zucc.), limber pine *Pinus flexilis* James), western white pine (*Pinus monticola* Dougl. Ex D. Don), and scots pine (*Pinus sylvestris* L.). A dozen other pine, spruce or fir are occasionally or rarely attacked.

Pissodes strobi has one generation a year. Adults hibernate in leaf litter over the winter under host trees and emerge in the spring and crawl up the host trees to the terminal shoot. Males and females begin feeding just below the terminal bud cluster. Eggs are laid in small urn-shaped feeding cavities made in the bark by the female. She seals the holes with a dark brown excrement cap to protect the eggs. Each female may lay 100 – 200 eggs. The 10 mm (.04 in) egg hatches in six to 14 days. As the eggs hatch, groups of larvae burrow down the leader in the inner bark, then between the wood and bark. During the following six weeks, the larvae molt four times. The larvae are white legless grubs, 9 – 10 mm (.36 – .4 in) long when fully grown. At the end of the feeding period, the larvae construct pupal cells in the pith and wood of the stem. They remain inactive for five to six weeks as pupae and as adults.

In July, August and early September, the adults chew small emergence holes through the cocoon and bark. As weather and temperature lower, the adults find shelter in the litter below the host trees. Although they may feed at the base of the tree, they eventually hibernate. Most will overwinter within 20 cm (8 in) of the boles of the host tree.

In the spring, tiny droplets of resin will exude from feeding sites made the previous year by adults below the terminal buds. Two to three weeks later, eggs are hatched in new punctures. Feeding by larvae can girdle the stem, causing the new shoot to wilt and the needles turn reddish-brown. Larval feeding may extend below one or more whorls of branches, thus all whorls above the larval feeding collar die. Weevil attack reduces tree height growth by 40 – 60% that year. Stem deformation is common to include forked or bushy tree form.

Monitoring and Inspection: Low water content of the terminal shoot reduces the numbers of eggs laid. Monitor rainfall before adults migrate to the terminal shoot. Do not water white pine at that time. Weevils prefer open growing trees with full sun on the terminals, so plant white pine under a hardwood overstory which slows terminal leader growth and lowers the temperature the weevils prefer for egg laying. Look for a crown closure of 50 – 70%. Plant white pine with mixed species in dense stands of 1.83 – 1.83 m (6 x 6 ft) spacing.

Management: Pruning infested terminals and branches at the first sign of wilting before adults emerge can reduce weevil populations. Destroy the pruned material. Band the base of the trunk with tape and apply sticky material (Tanglefoot) to the tape to prevent adult weevils crawling up the trunk in early spring (however, adult weevils are strong flyers). Removal of duff out to the drip line during winter after adult beetles have migrated into it may reduce the adult population. Natural enemies that may be effective are a dipteran predator, *Lonchaea cortices* (Taylor), and hymenopteran parasites *Eurytoma pissodis* Gir. and *Dolichotomitis terabrans nubilipennis* (Viereck). Parasitic nematodes may attack the overwintering adult weevils in the litter under white pine stands. *Heterorhabditis bacteriophora*, *Steinernema carpocapsae*, and *Steinernema feltia* are reported to attack soil-dwelling insects (although white pine weevil adults are not specifically listed). Chemical pesticides may be necessary if adult weevil populations are high (pesticides are not effective against larvae inside the terminal leader). Check with your local Cooperative Extension Agent.

WHITE-TAILED DEER - *Odocoileus virginianus*



White-Tailed Deer

The white-tailed deer is tan or brown in the summer and grayish brown in winter. It has white on its throat, around its eyes and nose, on its stomach and on the underside of its tail. The male has antlers. Males weigh between 150 and 300 pounds and females weigh between 90 and 200 pounds.

The white-tailed deer can be found in southern Canada and most of the United States, except for the Southwest, Alaska and Hawaii.

A deer's home range is usually less than a square mile. Deer collect in family groups of a mother and her fawns. When a doe has no fawns, she is usually solitary. Male bucks may live in groups consisting of three or four individuals, except in mating season, when they are solitary.

The white-tailed deer lives in wooded areas. In many areas, deer overpopulation is a problem. Gray wolves and mountain lions used to be predators of the white-tailed deer and helped keep their population under control.



White-tailed Deer Family

Disease and parasites like lice, mites and roundworms can weaken or kill deer. Young deer and old deer often get sick and die, especially in the winter. Their long narrow legs and pointed hooves make it hard for them to move around in the snow and ice and it is easier for predators like dogs to catch them.

Deer and people are living closer to each other because of human development and growth in deer and human populations. Because humans and deer often share a habitat, there can be problems for both of them. When a deer's habitat becomes smaller because of human development, deer will often eat food from gardens.

The white-tailed deer is an herbivore or plant eater. It follows well-used trails to its feeding areas. It feeds in the early morning hours and in the late afternoon. A deer's diet changes depending on its habitat and the season. It eats green plants in the spring and summer. In the fall, it eats corn, acorns and other nuts. In the winter, it eats the buds and twigs of woody plants. The white-tailed deer is a ruminant. Its stomach has four chambers for digesting food. This digestive system lets the white-tailed deer eat foods like woody plants that other animals can't digest! If deer have enough food, water and shelter, their population can grow very quickly.

White-tailed deer mate in November in the northern parts of their range and in January or February in the southern parts of their range. The female has one to three fawns about six months after mating. Fawns are reddish-brown at birth with white spots that help camouflage them. They can walk at birth and forage for food a couple of days later. They are weaned at about six weeks.



When a white-tailed deer is alarmed, it may stomp its hooves and snort to warn other deer. It may also "flag" or raise its tail and show its white underside. White-tailed deer are very good runners. They can run at speeds of up to 30 miles an hour. They are also good leapers and swimmers.

MANAGEMENT

There are five basic methods for preventing or managing deer damage to ornamental or historic plants. These are exclusion, cultural methods, scare methods, repellents and culling or harvest.

Exclusion can involve permanent or temporary fences such as electrical or woven wire fences. Temporary electrified fences are relatively simple and inexpensive for use during snow-free periods. Permanent woven wire fences of 2.44 – 3.05 m (8 – 10 ft) high are effective in excluding deer and require little maintenance, but are expensive to build. Fences can be vertical, slanted or augmented with three dimensional electrified outrigger wires.

Cultural methods require planting landscaping that is undesirable to deer (plants with bitter taste, milky sap, thorny, hairy or tough leaves). Deer may avoid these plants but still feed selectively on the desirable plants.

Scare methods may frighten or haze deer, but they tend to become accustomed to them, even when they are occasionally moved.

Repellents applied to the deer desired plants can be effective if periodically reapplied. The most effective deer repellents are those made from rotten eggs or thiram (a bitter-basting fungicide - check the label) in controlled tests. Switch repellents periodically. Half bars of Irish Spring soap has been used as a deer repellent (hanging on a string from branches) at MABI. Predator urine can also repel deer. Coyotes, cougars and wolves are natural enemies of deer and their urine odor may be repellent.

Culling the female deer may reduce feeding pressure by reducing the population. Special controlled hunts using black powder rifles or bow and arrows have been used in some states; however, this may be an unlikely option at SAGA.

Population control through sterilization of deer is also being done at some park sites (FIIS). Deer are attracted to feeding stations, tranquilized, and then inoculated with a contraceptive.

APHIDS



Aphids

Aphids are small, soft-bodied insects with long, slender mouth parts that they use to pierce stems, leaves and other plant parts to suck out plant fluids. They may be green, yellow, brown, red or black, depending on the species. Most adult aphids are wingless, but aphids have the ability to produce winged individuals which provides the pest with a way to disperse to other plants when the population increases or the quality of the food source decreases. Almost every plant has one or more aphid species that occasionally feeds on it. Many species are difficult to identify; however, identification to species is not necessary to manage them in most situations.

Aphids have many generations a year, with females giving birth to as many as 12 per day without mating. Nymphs shed their skins four times before maturing. There is no pupal stage. When the weather is mild, many species of aphids can develop from newborn nymph to reproducing adult in seven to eight days.

Monitoring: Check plants regularly for aphids. Many aphids cause the greatest damage when temperatures are warm but not hot. Catch infestations early. Once aphid populations are high and they have begun to distort and curl leaves, it is often hard to manage them as they are sheltered by the curled leaves. Check for evidence of natural enemies such as lady beetles or lacewings. Substantial numbers of natural enemies can mean that the aphid population can be reduced without treatment.

Ants are often associated with aphids. If you see large numbers of ants climbing up tree trunks or on plants, check for aphids on limbs and leaves above. To protect their food source, ants ward off many aphid predators and parasites. Management of ants is a key component to managing aphids.

Management: Natural enemies can be very important in the control of aphids, especially in gardens not sprayed with pesticides that kill the natural enemies as well as pests. Parasitic wasps lay their eggs inside aphids forming a “mummy.” Many predators such as the syrphid fly, lacewing and lady beetles feed on aphids. Both parasites and predators can greatly reduce aphid populations.

If you see ants crawling up aphid-infested plants, put a band of Tanglefoot around the trunk or stem to prevent ants from climbing up. Teflon products, which are too slippery for ants to climb up, have also been used on mature plants. Fabric wrap or duct tape can also be wrapped around the trunk and the sticky material applied to the wrap. Ant stakes or baits may also be used on the ground to manage the ants without affecting the aphids or their natural enemies.

Insecticidal soap or neem oil can provide temporary control if applied to thoroughly cover infested foliage. Other low-risk insecticides are available to use on aphids, however, these materials are not recommended as they will also kill the natural enemies that provide long-term management of aphids and other pests.

Aphid parasites such as *Aphelinus abdominalis*, *Aphidius colemani*, or *Aphidius matricariae*, should be released while aphid populations are low, so monitoring aphid populations is important. Aphid predators such as *Aphidoletes aphidimyza*, *Chrysoperla carnea*, *Chrysoperla rufilabris*, *Hippodamia convergens*, or *Orius insidiosus* can also be released to reduce aphid populations. Any of these aphid parasites or predators can be obtained from IPM Laboratories, Inc. in Locke, New York.

APPLE MAGGOT *Rhagoletis pomonella* (Walsh)

The apple maggot, also known as the railroad worm, is the most destructive pest of apples. They spend the winter in the ground as nonfeeding pupae. They begin to emerge from the soil as small (.64 cm [1/4 in]) flies in July. They are easily identified by the black and white band pattern on their wings. Peak emergence occurs from late July through early August. The flies emerge from the soil after a moderate rainfall and fly from tree to tree, although they stay in the general area. They can be found on foliage, fruit and bark. About one week after emergence, females begin to lay eggs in the apple flesh. In five to ten days, the eggs hatch into cream colored legless maggots that feed on the flesh of the apple fruit, leaving brown trails.



Apple Maggot Fly Larvae



Apple Maggot Fly Adult

Apple maggots cause two types of injury: around the area where the eggs are laid and the tunnels dug into the flesh, which causes the fruit to break down and rot.

Management: Sanitation is important in reducing apple maggot populations. Pick up and dispose of apples that have fallen to the ground within a few days.

Fair results can be obtained by capturing apple maggots with sticky red sphere traps which can be obtained from gardening stores or catalogs. Approximately five traps are needed per tree and should be hung by July 1st. Traps should be checked periodically and cleaned. Glue can be reapplied as needed.

Insecticide sprays are not recommended as no low-risk products were found to be effective in managing the apple maggot fly.

APPLE SCAB *Venturia inaequalis*



Apple Scab

Apple scab is of major economic importance in the mid-Atlantic region. If not managed, the disease can cause extensive losses (70% or greater) where humid, cool weather occurs during the spring months. Losses result directly from fruit or pedicel infections, or indirectly from repeated defoliation which can reduce tree growth and yield.

Apple scab can be observed on leaves, petioles, blossoms, sepals, fruit, pedicels, and less frequently, on young shoots and bud scales. The first lesions are often found on the lower surfaces of leaves as they emerge and are exposed to infection in the spring.

Later, as the leaves unfold, both surfaces are exposed and can become infected. Young lesions are velvety brown to olive green and have feathery, indistinct margins. As an infected leaf ages, the leaf surface becomes deformed. Leaves may become curled, dwarfed, and distorted when infections are numerous. The number of lesions per leaf may range from one or two to more than a hundred. Young leaves with scab often shrivel and fall from the tree. Infections of petioles and pedicels result in premature abscission of leaves and fruit. In late summer or early fall, lesions may appear whitish due to the growth of a secondary fungus on the lesion surface.

Lesions on young fruit appear similar to those on leaves, but as the infected fruit enlarge, the lesions become brown and corky. Infections early in the season can cause fruit to develop unevenly as uninfected portions continue to grow. Cracks then appear in the skin and flesh or the fruit may become deformed. The entire fruit surface is susceptible to infection, but infections early in the season are generally clustered around the calyx end. Fruit infections that occur in late summer or early fall may not be visible until the fruit are in storage.

Although research has shown that the scab fungus can overwinter in trees as conidia on bud scales, the pathogen generally overwinters in leaves and fruit on the orchard floor. Ascospores are the major source of primary inoculum and are produced within pseudothecia that develop in leaves during the winter months. The first mature ascospores are capable of causing infections at about the time of bud break or soon thereafter. Ascospores continue to mature and are discharged over a period of five to nine weeks, with peak discharge during the pink to petal fall phenological stages. The length of time required for infection to occur depends on the number of hours of continuous wetness and the temperature during the wet period. Young leaves remain susceptible for five to eight days, but their lower surfaces may become infected in late summer. For fruit, the duration of the wet period required for infection increases with the age of the fruit, which remains susceptible until harvest.

Once the fungus is established in the leaf or fruit, conidia form on the surface of the lesion and become the source of secondary inoculum for the remainder of the season. Conidia are disseminated to developing leaves and fruit by splashing rain and wind.

Consult with regional Cooperative Extension Service personnel to determine the onset of ascospore maturity. An awareness of the scab inoculum situation during the previous year and in adjacent abandoned or commercial orchards may influence early-season scab management decisions. During the prebloom period, for both fresh and processing apples, determine apple scab infection periods by observing duration of leaf wetness and average temperatures during the wet period. Begin monitoring for first leaf symptoms by examining the upper and lower leaf surfaces on a minimum of ten leaf clusters on each sample tree. In monitoring, walk around the perimeter of the tree and examine at least two leaf clusters at each of the four compass directions. Record the total number of clusters with scab lesions. For fresh market production, more than one infected leaf cluster per tree represents potentially damaging levels of apple scab.

During summer and pre-harvest, continue monitoring for lesions on leaves of vegetative terminal shoots and on fruit. Record the total number of terminals and fruit with scab lesions. More than one infected fruit per tree is a potentially damaging level for the fresh market. After harvest, for both fresh and processing apples, determine the percent of leaves infected and number of lesions per infected leaf on six terminal shoots from each sample tree after harvest and before natural defoliation begins. Greater than 0.5% leaves infected with an average of one lesion per leaf represents significant risk of early scab infection next season.

MANAGEMENT

Management of apple scab is multifaceted, with resistant cultivars, sanitation, and fungicide all being used to some degree depending on the orchard system being used and the goals of the grower.

Most of the major apple cultivars are susceptible to the fungus.

Prevention of pseudothecial formation in overwintering apple leaves would eliminate scab as a serious threat to apple production. Leaf and fruit pickup and destruction in late autumn can be employed. Flail mowing in late autumn to chop litter can help reduce numbers of pseudothecia. Applications of 5% urea to foliage in autumn can hasten leaf decomposition, thus reducing formation of pseudothecia. Applications should be made just prior to leaf fall to avoid stimulating tree growth and making the trees susceptible to winter injury.

Apple scab is treated primarily with fungicide sprays. Protectant fungicides prevent the spores from germinating or penetrating leaf tissue. To be effective, they must be applied to the surface of susceptible tissue before infection occurs. Occurrence of infection can be predicted with an accurate weather forecast.

Post-infection fungicides control the scab fungus inside leaves and fruit. The ability of these fungicides to stop infections is limited to a few hours, or up to few days, and often varies with temperatures during the first 24 to 48 hours after infection. Eradication of scab lesions after they appear does not occur. Good horticultural practices, such as proper site selection, tree spacing and annual pruning, facilitates scab management.

BLACK ROTS

BLACK ROT OF APPLE *Botryosphaeria obtuse*



Black rot of apple is a fungal disease that can cause serious losses in apple orchards. Three disease forms occur: fruit rot, leaf spot and limb canker.

Leaf symptoms first occur in early spring when the leaves unfold. Small purple specks appear on the upper surface of the leaves that enlarge into circular lesions 3 – 6 mm (1/8 – 1/4 in) in diameter.

Fruit infection is the most common form, and result in blossom rot later in the season. Limb canker appears as a wound in the bark, and can result in complete girdling of the limb. This black rot fungus can be found on wood previously killed by fire blight or damaged by cold temperatures.

The fungus overwinters in cankers, especially in those initiated by fire blight, in dead bark, and in mummified fruit. In the spring, spores are released by rainfall; the amount and duration influencing spore release, germination and infection.

Monitoring: Check each tree for cankers. Remove cankered wood from the orchard or mulch the brush so that it decays over the period of a year. Inspect trees for mummified fruit and remove it from the orchard. If leaf spots are observed, it may be possible to locate dead wood, cankers and mummified fruit. These should be removed if possible.

Management: Removing dead wood, mummified fruit and cankers from the trees are important cultural practices that may help reduce the incidence and severity of the disease. Prunings should be removed from the orchard and burned, or raked and then chopped with a flail or rotary mower. Piles of prunings can serve as sources of fungal spores. Fungicides can be used from silver tip through harvest. Check with local Extension Agents for specific recommendations.

BLACK ROT OF GRAPE *Guignardia bidwellii*

Black rot is one of the most damaging grape diseases. All cultivated varieties are susceptible to infection by the fungus. The disease is encouraged by warm, humid weather. Symptoms first appear as small, yellowish spots on leaves. As these lesions enlarge, a dark border forms around the edges. By the time the lesions are .3 – .64 cm (1/8 – 1/4 in) in diameter, black dots appear. These dots are fungal fruiting bodies which contain thousands of spores.



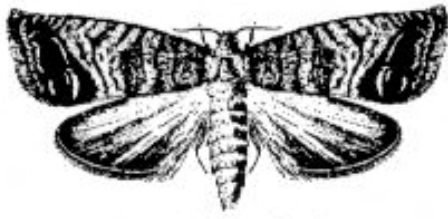
Fruit symptoms appear when the grapes are about half grown. Small round spots form on the fruit which enlarge quickly, rotting the entire fruit in a few days.

Black rot survives the winter in cane, lesions and fruit mummies. In the spring during wet weather, the fungal fruiting bodies on infected tissues absorb water and spores are squeezed out. These spores are splashed about by the rain and can infect any young tissue in less than 12 hours.

Monitoring: Check each vine often for leaf spots and rotting or mummified fruit. Remove the fruit from the vines. In the spring, if only a few leaf lesions appear, remove those infected leaves.

Management: Sanitation is important. Destroy mummies, remove diseased tendrils, and canes with lesions. It is important not to leave mummies attached to the vine. Mummies on the ground release most or all of their spores before the end of bloom. Mummies left on the vines or trellis can produce spores throughout the growing season. Plant grapes in sunny open areas that allow good air movement. Fungicides can be used from silver tip through harvest. Check with local Extensions Agents for specific recommendations.

CODLING MOTH *Cydia (Laspeyresia) pomonella*



Codling Moths

Codling moth is a serious pest of apples, pears and English walnuts. The adults are about 1.27 – 1.91 cm (1/2 – 3/4 in) long with mottled gray wings. Their appearance blends in remarkably well with tree bark. The larvae are white to light pink “worms” with a dark brown head. They are one of the few worms that are likely to be found inside the fruit of an apple or pear.

Codling moths overwinter as full-grown larvae inside thick cocoons under loose scales of bark or in soil or debris around the base of a tree. The larvae pupate inside their cocoons in early spring and emerge as adult moths from mid-March to early April. The moths are active for only a few hours before and after sunset. After mating, the female deposits 30 to 70 eggs singly on fruit or leaves. After the eggs hatch, larvae seek out and bore into fruit. After maturing,

they leave the fruit, drop from the trees and search out pupation sites.

On apples and pears, larvae penetrate into the fruit and tunnel to the core leaving holes in the fruit that are filled with reddish-brown frass.

Management: In existing trees, the most effective non-chemical control methods include sanitation, trapping, trunk banding and fruit bagging. Pruning trees to a height where the canopy is easy to reach will facilitate management.

Sanitation should be the first step in a codling moth control program. Every week, check fruit on trees for signs of damage. Remove and destroy any infested fruit showing frass-filled holes. Removing the fruit while the larvae are still inside is a very effective method of reducing the population. Thinning out the infested fruit also encourages the remaining fruit on the tree to grow larger. Clean up, bag and dispose of any dropped fruit as soon as possible after it falls.

Hanging traps in each tree can help to reduce populations but won't completely eliminate damage. Codling moth traps are available from many commercial sources (see Vendors) and online. These traps usually have a sticky cardboard bottom and are baited with a pheromone to attract the males

Banding the trunk of a tree with a cardboard band to trap the larvae as they climb works best on smooth-barked trees. This method will only control a small percentage of the population and works best when used in conjunction with sanitation and trapping.

Bagging each individual fruit is an excellent method of control and is effective enough to be used alone. It is, however, very time consuming and labor intensive.

There are a few natural predators of the codling moth such as spiders or carabid beetles, but are not plentiful enough to control a large population. Release of the tiny wasp *Trichogramma platneri* has been used successfully to manage codling moth in conjunction with mating disruption and/or low-risk pesticides.

Spinosad is one of the few low-risk insecticides that are available to manage codling moth. This is a biological product with low toxicity and is low-risk for most beneficial insects as well as people. The residual is only about 10 days, however, so repeated applications will be necessary.

FIRE BLIGHT



Fire Blight

Fire blight, caused by the bacterium *Erwinia amylovora*, affects over 130 plant species in the rose family. Fire blight is most often seen on apple, crabapple, pear, mountain ash, and cotoneaster.

Bacteria survive winter near the edge of cankers and become active in the spring during warm, humid weather. Bacterial ooze, a sweet and sticky substance containing bacteria and plant sap, flows out of infected trees through natural openings and cracks in the bark. Bacterial ooze

can be spread to young succulent growth on nearby plants by wind, rain, or birds. Pollinating insects attracted to the sweet smelling ooze are responsible for transmitting the bacteria to flowers of susceptible hosts.

Infected flowers first appear water-soaked, then shrivel, turning brown or black. As the infection progresses, leaves on the same spur turn dark brown or black as though scorched by fire. The dark, shriveled leaves hang downward and usually cling to blighted twigs. Infected shoots, twigs, and suckers turn brown to black and often bend in a characteristic shepherd's-crook. Infected immature fruit turns dark, shrivels, mummifies, and rots. Mummified fruit may cling to the tree for several months.

A canker is formed when an infection progresses into larger branches. The host may produce callus tissue that walls off the canker, or a host may continue to be infected causing death of the branch. Weather conditions are an important variable influencing the severity of fire blight. New infections may occur throughout the growing season during warm, humid weather, and are common after a summer hailstorm when bacteria are washed into wounds created by hail.

MANAGEMENT

Cultural practices, such as proper pruning, fertilizing, and site selection, can help prevent or minimize fire blight. Young, succulent growth is very susceptible to fire blight, so avoid heavy pruning which stimulates excessive new growth. Prune young trees annually during dormancy (late winter) to eliminate the danger of large cuts which may promote the growth of suckers. Use a balanced fertilizer early in the spring to encourage tree growth during the first part of the season when temperatures are cooler and less conducive to the spread of fire blight. Excess nitrogen stimulates new growth, which is highly susceptible to fire blight, so fertilize only as needed. Trees with dark green, well-developed leaves and adequate growth would not benefit significantly from an application of fertilizer.

Diseased twigs, branches, and trees may be removed in late winter. Cuts should be made at least six inches below the diseased area into healthy wood and at a proper pruning site. Summer pruning can be hazardous; however, susceptible trees may be killed if the disease is not pruned

out as soon as possible. Infected twigs and sprouts which are pruned in summer should be cut at least twelve inches below the point of visible infection and at a proper pruning site. Pruning shears should be dipped for five seconds in a freshly made 10% bleach solution (one part bleach to nine parts water, equivalent to 1½ cups bleach in one gallon of water) between each cut.

If trees are severely infected or if fire blight continues to be a yearly problem, a copper-based fungicide like Bordeaux Mixture or a fire blight spray containing streptomycin sulfate can be applied. Follow directions on the label for application procedures. Read the label carefully and apply only as directed.

MEADOW VOLES

Voles are compact rodents with stocky bodies, short legs and a short tail. Their eyes are small and their ears are partially hidden. Their fur is dense and usually brown or grey.



Meadow Vole

The meadow vole (*Microtus pennsylvanicus*) is the most widely distributed *Microtus* in the United States. The meadow vole is 14 – 19 cm (5 ½ - 7 ½ in) long with grey to yellow-brown fur and black-tipped hairs. Its underparts are grey and the tail is bicolored. It prefers damp meadows and grassland habitats.

The pine vole (*Microtus pinetorum*) or woodland vole is small, 10 – 15 cm (4 – 6 in) long. Its fur is brown with grey underparts. Its tail may be barely bicolored or unicolored.

It prefers heavy ground cover in deciduous or pine forests, abandoned fields and orchards.

Voles are active day and night year around, and do not hibernate. Home range is usually 0.1 hectares (1/4 acre) or less. Voles construct many tunnels and surface runways with a number of burrow entrances. Voles have from one to five litters a year with an average of three to six young per litter. Population fluctuations are large and peak every two to six years. High vole densities may reach up to 1,250 per hectare (500 per acre). Life spans are short, ranging from two to 16 months.

DAMAGE

Voles may cause extensive damage to orchards and forests by their girdling of seedling and mature trees. Voles are mostly herbaceous, feeding on a variety of grasses, herbaceous plants, bulbs and tubers, as well as bark and roots of trees; usually in the fall and winter. Voles are poor climbers and seldom enter buildings.

MANAGEMENT

Managing voles involves exclusion and habitat modification. Exclude voles from orchard trees by enclosing each tree in .64 cm (1/4 in) hardware cloth, 30.48 cm (12 in) above soil level and buried 15.24 cm (6 in) deep. Modify the habitat by regular close mowing of the ground cover in the orchard (or other vole habitats) or tilling the areas with tunnels and burrows. Snap traps (with chunky peanut butter bait) placed in runways can also be effective in reducing the number of voles. The reproductive capability of voles may require a substantial number of traps.

EASTERN MOLE *Scalopus aquaticus*



Eastern Mole

The eastern mole is about 15.24 – 20.32 cm (6 – 8 in) in length and can weigh 84 – 168 gr (3 – 6 oz). Each year a mole can have one litter of two to six young, depending on the female's health. Gestation lasts about five to six weeks and the young are born between mid-April and mid-May. Young moles have less than a 50% chance of surviving long enough to reproduce.

Moles are insectivores whose primary food source is earthworms. They spend the majority of their life below the ground, and their activity can cause damage to lawns and turf. This damage is in the form of tunnels and/or mounds that can be unsightly and disturb root systems. Moles can quickly colonize and spread through adjacent properties. Because they need a well-established tunnel network to survive, management will be more difficult the longer they are allowed to tunnel and become established. In large areas, moles may move from one part of the property to another. This movement is affected by climate and ground moisture. They will also respond to changes in food supply as different insect larvae become available in different places and different times throughout the year. If disturbed, moles may temporarily leave an area, but will return. Even without disturbance, mole activity may only last a short time in a particular area.

Over-watering turf can bring soil invertebrates and moles closer to the surface making tunnels more visible. Reducing the amount and frequency of watering may help. Numerous home remedies have been used, but results are generally ineffective. Moles provide benefits to meadows and turf by turning soil, mixing soil nutrients, and improving soil aeration. Modifying the turf species to include native grass and forbs for an environmentally sound landscape can eliminate mowing and other manipulations.

MANAGEMENT

If necessary, trapping is the most effective and practical method of managing moles. Trapping success tends to be greatest in the spring and fall, especially after rain. In the summer and winter, moles are active in deep soil and are more difficult to locate. To ensure safe and humane deployment, be sure to follow printed instructions. Traps should be set in active surface burrows. Two types of traps are available: harpoon traps and chokers. The harpoon trap consists of two prongs that straddle the mole tunnel and a set of spring-driven spikes. The spikes are raised above the tunnel and catch in the trigger release. When the mole triggers the trap, the prongs are released and driven through the sod, impaling and killing the mole. A choker trap consists of a cast-metal frame with two spring-retractable loops. Two slits are cut in the tunnel and the set loops are placed inside. When the mole triggers the trap, it is immediately crushed. When using traps, place a plastic pail with a warning sign over each trap. Set three to five traps per acre.

PLUM CURCULIO

The plum curculio, *Conotrachelus nenuphar* (Herbst), is widely distributed east of the Rocky Mountains and is a native insect. The name is somewhat misleading because this insect attacks not only plums, but also apples, peaches, pears, cherries, quince, and other wild and cultivated fruits. It can be very destructive. Injury to all hosts results first from the spring feeding of adult beetles, then from female egg punctures in the fruit, next from the feeding of larvae within the fruit, and finally from the early fall feeding of adult beetles.

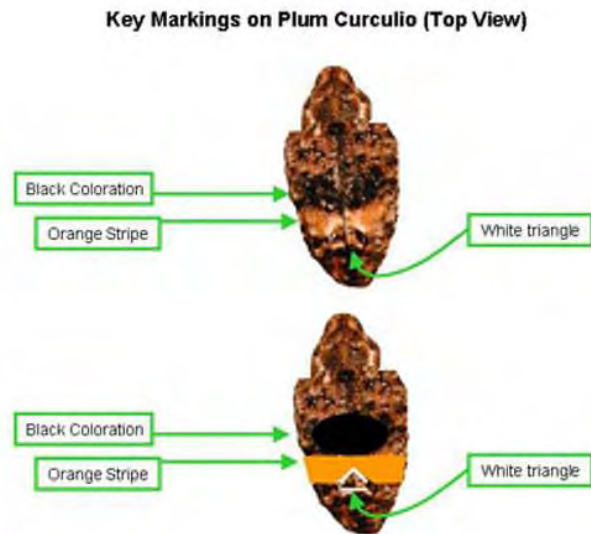
Both the adult and larval stages injure fruits.

In spring, adults feed on buds, blossoms, leaves and new fruits. Feeding scars appear as shallow cavities on the fruit surface. The major injury occurs from the laying of eggs by the curculios (weevils). A small cavity is made in the fruit for the egg; then a crescent-shaped cut is made adjacent to the egg pocket. Fuzz on peaches makes it difficult to see this egg scar. The early feeding and egg-laying punctures can cause marked scarring and malformation of the fruit. Early feeding on the surface of peaches often causes severely deformed fruits known as "cat-faced" peaches. The mechanical injury by adults in feeding and egg deposition can cause premature fruit drop. When the summer brood of adults appears, feeding cavities again can be found on the fruits.

The adult plum curculio is a small, hard-bodied, brownish-black snout beetle mottled with white and orange areas. It has four prominent black humps on its top surface. It is about 6 mm (.24 in) long, has a long snout, the end of which bears chewing mouthparts. The insect overwinters as an adult under debris in protected places in an orchard. In spring, shortly after peaches bloom or when apples are near the pink stage, the beetles come out of hibernation and begin to fly to fruit trees to feed.

Egg-laying begins as soon as the young fruits form and continues for three or four weeks. To lay eggs, the female first cuts a small, round cavity directly under the skin of the fruit with her mouthparts. Then she turns around and lays a single tiny white egg in the cavity, just under the skin of the fruit. After this, she cuts a crescent-shaped slit nearly halfway around the cavity, creating a dead flap in the surface of the fruit.

A single female lays about 60 to 150 eggs. Within seven days, larvae emerge from the egg and begin to eat their way through the flesh of the fruit. In stone fruits, the larva works its way toward the pit, around which it feeds extensively until it is fully grown. On apples, few if any of the young larvae survive if the apple continues to grow on the tree because the egg or larva is crushed by the firm, growing tissues of the fruit. If the apple drops prematurely or is picked



from the tree while the larva is still alive, or the variety is an early ripening one, the larva can complete its feeding and growth. The larva spends about 10 to 16 days feeding. On reaching completion of its development, the larva burrows out of the fruit by making an oval exit hole and enters the soil. At this stage, the larva is about 9 mm (.35 in) long and is a yellowish-white, legless grub with a brown head.

In the soil, the larva constructs a small cell 2.54 – 7.62 cm (1 – 3 in) deep, in which it transforms into a whitish pupa and then into an adult. The time between the entrance of the larva into the soil and the appearance of the new beetle above ground is about five weeks. Summer brood adults emerge in July and August. They do not lay eggs but instead feed on fruit, showing a preference for smooth-skinned fruits such as apples and plums.

In feeding on apples, the beetle makes a small hole in the skin of the fruit and then devours all the flesh of the fruit it can reach with its snout. This feeding takes place until the adults enter hibernation, which occurs from September through early November.

MANAGEMENT

Jarring the sluggish beetles from trees in the morning and capturing them on sheets is a physical management method. Natural control of the curculio results from winter mortality, attacks by birds and other predators, and from parasites. Pick up fallen fruit two to three times a week, put it in a plastic bag, tie it tightly and place it in the trash can. This will help keep larvae in fallen fruit from developing in the soil and, if done regularly, should lessen the damage done by this insect. Lightly tilling the soil (2.54 – 7.62 cm [1 – 3 in]) in the orchard in late June will reduce the numbers of pupating larvae.

POWDERY MILDEW



Powdery Mildew

There are numerous fungi that fall under the general description of a powdery mildew. Outdoors there are numerous plants that may be infected in any year; but lilac, phlox, some rose varieties and fruit trees seem to be infected most frequently. The actual injury to the plant varies greatly with the species and even the variety attacked. For instance, lilacs are typically infected late in the growing season and this does not usually cause serious injury to the plants. Lilacs are able to survive year after year in spite of the disease. On the other hand, begonia may be seriously injured by even a mild

infection. The tissue under the fungal growth dies soon after infection resulting in leaf drop and poor plant growth. Thorough management practices must be implemented in this case. Among roses there are varieties that are more seriously affected than others. If powdery mildew has been a problem in the past, choose a variety that has some resistance to the disease.

Powdery mildew appears as a dusty white to grey coating over leaf surfaces or other plant parts. In most cases this fungal growth can be partially removed by rubbing the leaves. Powdery mildew will begin at discrete, usually circular, powdery white spots. As these spots expand they will coalesce, producing a continuous mat of mildew.

Symptoms usually appear late in the growing season on outdoor crops. The fungus is favored by periods of high relative humidity or site conditions that promote a more humid environment, such as close spacing of plants, densely growing plants or shade.

Injury due to powdery mildews includes stunting and distortion of leaves, buds, growing tips and fruit. The fungus may cause death of invaded tissue. Yellowing of leaves and death of tissue may result in premature leaf drop. Nutrients are removed from the plant by the fungus during infection and may result in a general decline in the growth and vigor of the plant. The seriousness of the disease will depend on the extent of the various types of injury.

The fungi which cause powdery mildew are spread by spores produced in the white patches. These spores are blown in the wind to other parts of the plant or to other plants during the growing season. Generally each species of fungus will be limited in the number of plant species that can be attacked. For example, the species of fungus infecting lilacs will not cause powdery mildew on apples.

During the winter the fungus survives on infected plant parts and in debris such as fallen leaves. It may produce resting structures known as cleistothecia, which resist harsh winter conditions. These will appear as small black dots within the white powdery patches. The next spring, sexual spores (ascospores) are released from the cleistothecia, shot up into the air, and carried by air

currents to leaves of plants where new infections will begin. During the growing season, the fungus produces asexual spores (conidia) that help the fungus to spread and the infection to build. This is the general cycle for most powdery mildews of outdoor plants.

MANAGEMENT

There are several effective fungicides available for different sites and plants, but use on plants varies with each product, and not all fungicides registered for use to treat powdery mildew may be used on all plants. Be certain the product you purchase is labeled for the intended use(s), and follow directions on that label.

For outdoor ornamental plants, gather up fallen leaves in autumn and destroy them. Where powdery mildew is a problem, resistant varieties (if available) should be grown. If needed during the growing season, begin fungicide applications when the first white patches are noticed. Repeat as indicated on the product label during cool humid weather. Some products with a broad range of applications for outdoor ornamentals include *Bacillus subtilis*, jojoba or neem oil, potassium bicarbonate, sulfur or lime sulfur. Some of these products may also be used to treat powdery mildew infections in the vegetable garden. Other products may also be available, so your local Cooperative Extension Office can be contacted for more information.

Management of powdery mildew on fruit trees should begin at the green tip bud stage for apples and may include some products containing the active ingredients *Bacillus subtilis*, neem oil or potassium bicarbonate.

Wettable sulfur is known to cause injury to some plants. Check labels for cautions about sensitive plants.

SCALES



Scales

Scale insects can be serious pests on all types of woody plants and shrubs. Adult female scales and many immature forms do not move and are hidden under a waxy covering. They lack a separate head or other recognizable body parts. Scales have long, piercing mouthparts with which they can suck juices out of plants. They occur on twigs, leaves, branches or fruit. Severe infestations can cause overall decline and death of plants.

Armored scales, family *Diaspididae*, are less than .30 cm (1/8 in) in diameter and have a platelike cover. They are called armored scales because the scale cover is quite dense and provides protection from pesticides and parasites. They hatch from eggs, settle down and lose their legs, then form a hard cover that is separate from the body. Armored scales do not excrete honeydew.

Female soft scales, family *Coccidae*, may be smooth or cottony and have a diameter of .64 cm (1/4 in) or less. They are usually larger and more rounded than armored scales. Most immature soft scales retain their legs and antennae after settling and are able to move. Soft scales produce large quantities of honeydew that drips from their bodies.

Most armored scales have several generations a year, while most soft scales often have only a single generation. Eggs of both types are usually hidden under the adult female. Eggs hatch into tiny, usually yellow crawlers with legs. Crawlers walk over the plant surface, are blown by wind to other trees, and can be inadvertently moved by people or birds. Adult female scales are immobile and have a characteristic scale. Adult males are tiny winged insects that resemble parasitic wasps. They are rarely seen, do not feed, and live only a few hours.

Woody plants heavily infested with armored scales often look water stressed. Leaves may turn yellow and drop; twigs and limbs on trees may die, and bark may crack and produce gum. Many armored scales attack leaves or fruit as well, leaving blemishes and halos on fruit.

Soft scales also reduce tree health, but seldom kill trees. The major concern with these scales is their production of honeydew which gets on leaves and fruit, encouraging the growth of black, sooty mold. Honeydew also attracts ants which protect soft scales from natural enemies. Soft scales infest leaves and twigs, and do not attack fruit directly.

MANAGEMENT

Scales are often well managed by natural enemies, especially when predator and parasite activities are not disrupted by ants or applications of broad-spectrum insecticides. Scale predators (*Cryptolaemus montrouzieri* and *Rhyzobius lophanthae*) and scale parasites (*Aphytis*

melinus, *Leptomastix dactylopii*, and *Metaphycus helvolus*) are available from commercial insectaries. In the case of soft scales, managing ants may be sufficient to bring about gradual control of scales. If not, well-timed sprays of oil applied either during the dormant season or when crawlers are active in the spring should provide management.

Monitor scales by inspecting plants for crawlers, mature females or ants. Dead scales from previous generations can remain on plants. Examine deciduous plants when leaves are off in the winter. Trees, bushes, twigs and branches heavily infested with scales may retain their leaves during winter and be easy to spot.

If possible, provide plants with appropriate irrigation so they are more resistant to scale damage. Prune off heavily infested twigs and branches to eliminate scales when infestations are on selective parts of the plant. Prune to open up tree canopies to increase heat exposure which increases scale mortality.

If large numbers of ants are climbing up trunks to tend scales, they should be managed. On ornamental plantings, deny ants access to plant canopies by pruning branches that provide a bridge between structures or the ground; and by applying a sticky material (such as Tanglefoot) to trunks. If trees are young or recently pruned, wrap the trunk first with a strip of fabric tree wrap, duct tape or other material which doesn't injure the tree.

Dormant season applications of specially refined oils or soap alone is usually adequate. Don't apply oils during the fog or rain. Horticultural oils can also be used in spring or summer against crawlers on deciduous plants. Use traps made of double-sided sticky tape to determine when crawlers are hatching. Change the tapes weekly and examine the tapes with a hand lens. Once eggs begin hatching, scale crawlers get stuck on the tapes and appear as yellow or orange specks.

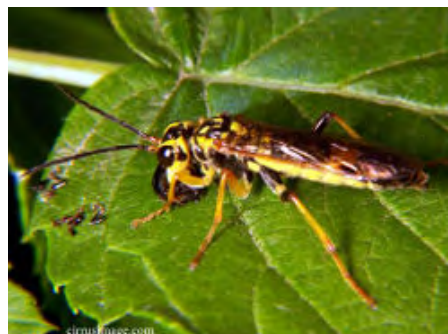
SAWFLIES



Sawfly (*Tenthredo marginella*) Larva

Adults are rarely seen and do not sting. Generally they overwinter as a pre-pupa in a cocoon in the ground, pupating in the spring. Only one generation is produced each year.

One particular sawfly which is a troublesome pest in apple orchards is the European apple sawfly (*Hoplocampa testudinea* [Klug]). The larvae feed on all apple and crabapple varieties, and show a decided preference for early or long-blooming varieties with a heavy set of fruit. The adults are 6 – 8 mm (1/4 – 1/2 in) in length with yellow heads and antennae. The female lays her eggs in apple blossoms. They hatch within one to two weeks.



Sawfly Adult

Monitoring: European apple sawfly adults are visually oriented toward apple blossoms. Tests have found sticky white rectangles to be the most effective trap for capturing and monitoring adult populations.

Management: As the sawfly is an introduced pest from Europe, many of its natural enemies remained behind. The absence of such enemies is a major reason for the pest's successful establishment in the U.S. Using the white sticky traps mentioned above are effective for decreasing adult sawfly populations.

Application of insecticides usually provides adequate control; however, because the sawfly is a hymenopterous insect, insecticides that manage it also adversely affect bees. For this reason, no products are listed here. It is suggested that the local Cooperative Extension agent be consulted with about possible low-risk insecticides for use on this pest.

TWO-SPOTTED SPIDER MITE *Tetranychus urticae* (Koch)



Two-Spotted Spider Mite

The two-spotted spider mite is widely distributed and a common pest of orchards and nursery plants. When environmental conditions are hot and dry, spider mites multiply rapidly and become a pest. Initial infestations tend to occur in areas bordering clover fields or grassy areas. Field perimeters and corners tend to exhibit the earliest symptoms of infestation. Dispersal over a wide area occurs when spider mites are carried on a balloon of their webbing by the wind.

Two-spotted spider mites feed on the underside of the foliage with sucking mouth parts and may be very destructive when abundant. Under hot and dry conditions, spider mites thrive on plants that are under stress. The juices which the mites obtain from stressed plants are rich in nutrients and the mites multiply rapidly.

Adult two-spotted spider mites are only about .35 mm (1/60 in) in length and have a black spot on each side of their bodies, which ranges in color from white to light red. The eggs of the mites appear like small clear or pale marbles when viewed through a hand lens.

Two-spotted spider mites overwinter as adult females. Egg laying begins in late April or May; the eggs hatch in five to eight days into the protonymph (six legs) stage, which later molts to a deutonymph (eight legs) stage. The time from egg to adult normally requires about three weeks, but may take less time under hot and dry conditions. Depending on the weather, five to ten generations may occur within a growing season. Spider mite reproduction and population multiplication will persist until cool weather of late summer leads to a reduction of population activity.

In assessing the degree of a spider mite infestation, it is important that one recognize the stippling or speckled effect on green foliage which is the early sign of mite feeding. It is essential to use a good hand lens to view the relative abundance of mites in egg, nymph and adult stages.

MANAGEMENT

When conditions are optimal for spider mite outbreaks, early detection facilitates timely and effective treatment. Since mite development is linked to host plant stress, cultural practices and varieties which limit plant stress in times of drought will also minimize the development of spider mites. Narrow-range oil sprays can provide effective management. Two-spotted spider mites are known to have developed resistance to miticides quite rapidly. Introduce predator mites (*Neoseiulus fallacis* or *Phytoseiulus persimilis*) to greatly reduce the mite population.

ARMYWORM *Pseudaletia unipuncta* (Haworth)



Army Worm Larvae

Armyworm is in the Lepidoptera order known as moths. The larvae cause defoliation damage that results in turfgrass thinning. They are known to mass together and move in large groups to new food sources causing defoliation damage along the way.

Armyworm varies in length from 2 mm (1/16 in) to 35 – 50 mm (1 1/2 – 2 in) as mature larvae. The larvae have stripes running the length of their body. They are hairless caterpillars ranging from yellow-green to dark brownish-gray.

The armyworm is a native species which occurs throughout the United States east of the Rocky Mountains. They attack mainly grasses such as small grains. However, grasses such as pasture grasses, turfgrasses and corn are fed on. Armyworms inhabit the thatch layer unless it is very dry. Then they will harbor inside soil cracks and under ground litter.

Armyworms pass the winter as larvae in the soil or under debris in grassy areas. Growth occurs continuously except in very cold weather. They feed the following spring until fully grown, then will pupate over a 15 – 20 day period. Adults emerge in May and June. Females feed on nectar, decaying fruit or honeydew right before laying eggs. A single female may live as an adult for 17 days and produce up to 2,000 eggs. Eggs hatch in 6 – 10 days. Young caterpillars feed on leaves mainly at night or on cloudy days. They cannot survive exposure to temperatures above 32°C (90°F). Defoliation proceeds at a fast rate because of the large size caterpillars and population growth.

Monitoring: A detergent flush can be used to determine larval thresholds. Apply 56 g (2 oz) of liquid dishwashing liquid per gallon of water to a 1.22 sq m (4 sq ft) area. If larvae are present, they will come to the surface within a few minutes. Black light traps can also be used to monitor adult moth flight activity.

Management: This species is susceptible to a wide variety of pathogens. *Bacillus thuringiensis* products such as Steward and Dipel will provide effective control if applied to young larvae. Other effective biocontrol products include entomopathogenic nematodes *Steinernema carpocapsae* (Vector) and *Heterorhabditis bacteriophora* (Cruiser). Larvae may also be effectively controlled by the parasite tachinid fly *Winthemia quadripustulata*. Predators include ground beetles, birds, toads, domestic fowl and small mammals.

BIRCH LEAFMINER *Fenusa pusilla*

One of the major pests of birch trees is the birch leafminer. This pest gets its name from the larval habit of feeding or mining the plant tissues between the surfaces of the leaves. It was accidentally introduced from Europe. The adults are small, black, and about .3 cm (1/8 in) long. The adults overwinter in the soil and begin to emerge in early to mid-May. They congregate about birches, mate, and females lay their eggs in newly-developing leaves. Host trees are most likely to be gray, paper and European white birch.



Birch Leafminer Adults

Leaves that are attacked soon turn brown. Affected trees seen from a distance have a scorched or blighted appearance that is often mistaken for a disease. The top of the tree is most often the part most seriously affected; however, the entire tree can be attacked. A healthy tree can lose part of its current crop of leaves without being seriously weakened; but repeated losses year after year will weaken the tree and make it susceptible to attack by other insects and possibly death.

Eggs hatch in seven to 10 days, and the larvae begin feeding immediately. As the larvae grow, blotches and blisters begin to form on the leaves.

Management: Azadirachtin is shown to have systemic activity against birch leafminer following injection into the tree. Contact can be made with the local Cooperative Extension Office to determine if any other low-risk management methods are available and effective.

BIRCH SAWFLY *Arge pectoralis*



Birch Sawfly Adult

The yellowish-green larvae of this insect are occasionally found feeding around the edges of birch leaves. Branches may be stripped of foliage and small trees may be defoliated. The full-grown larvae are about 2.54 cm (1 in) long with a row of black spots along their sides and black heads. There may be several generations a year and larvae may be found from spring until fall. The larvae are social and feed in groups, and are often seen with their back ends elevated. The adult of this insect is a wasp. They overwinter in a cocoon in the topsoil and adults emerge in May and June.

Management: If the infestation is light, try hand picking the larvae. Although they resemble caterpillars, they are not. Therefore, *Bacillus thuringiensis* is not effective against this pest. Spinosad sprayed when the larvae are feeding should provide control. If approved and labeled, Imidacloprid as a systemic to be taken up by the roots provides season-long control.



Birch Sawfly Larvae

BOTRYTIS GREY MOLD



Botrytis Gray Mold

Botrytis grey mold, or bunch rot, is caused by the fungus *Botrytis cinerea*. It is common in nature and causes diseases on a variety of unrelated crops. Bunch rot can cause serious losses on highly susceptible grape varieties.

Infection of ripe fruit is the most common and destructive phase of this disease. The fruit will first appear soft and watery. Under high humidity and moisture, infected grapes usually become covered with a gray growth of fungus mycelium. Healthy fruit that comes in contact with infected fruit will also become infected. Rotting fruit will shrivel in time and drop to the ground as hard mummies. The disease can also cause blossom blight early in the season. Although uncommon, leaf infections also occur.

The fungus overwinters in grape mummies, dead grape tissues and other organic debris in and around the grapevines. Because of its wide range of hosts, it should be assumed that the fungus is present. In spring, the fungus germinates, and then produces spores that spread the disease.

Management: Promote good air circulation and light penetration by proper pruning, controlling weeds and suckers, and positioning or removing shoots for uniform leaf development. Good air circulation and light penetration facilitate faster drying of plant parts and reduce the risk of disease. Removal of leaves around clusters on mid or low vines has been shown to reduce losses. Care should be taken to prevent wounding by managing insects, birds and other grape diseases. Growth regulators that separate the berries in tight clustered cultivars can reduce the damage from berries being crushed; thus, reducing infection and spread of *Botrytis*.

Although fungicide sprays are generally effective applied at appropriate times during the growing season, they are generally not required for small plantings. Encourage the use of the previously described cultural practices in order to reduce or eliminate the need for fungicide use.

BOTRYTIS OF PEONY

Botrytis blight is a fungus disease which infects a wide array of herbaceous annual and perennial plants. There are several species of the fungus *Botrytis* which can cause blights; the fungus *Botrytis paeoniae* infects peony. *Botrytis* infections are favored by cool, rainy spring and summer weather usually around 15°C (60°F). The fungus can be particularly damaging when rainy, drizzly weather continues over several days.



***Botrytis* of Peony**

During wet or humid weather, examine any brown or spotted plant material that develops and look for masses of silvery-gray spores on the dead or dying tissue. These spores may appear as a dust coming off heavily infected plant material. The *Botrytis* fungus can affect leaves, stems, crowns, flowers, flower buds, seeds, seedlings, bulbs, and all other parts of the plants except the roots.

New infections begin in the spring as soon as weather conditions are favorable. Fungal mycelium may overwinter in woody stem debris. Spores then germinate in the spring and the infection develops.

Management: The best way to manage this disease is by inspection and sanitation. Carry a paper bag for sanitation while inspecting plants. Remove faded or blighted flowers, blighted leaves, or entire plants infected at the base and place them in the paper bag so they can be discarded with the trash or burned. Avoid sanitation when plants are wet since this could spread spores. Avoid overwatering and space them to allow good air circulation. Remove dead plant debris in the fall. Cut stalks at or below ground level and destroy this plant debris.

Avoid the use of dense, wet mulches and, if necessary, apply fungicide spray in early spring just as the red shoots begin to push up out of the ground. With continuous inspection and careful sanitation, *Botrytis* can be effectively managed. Keep an eye out for the silvery-gray mold and/or tiny black spores which are sure signs of the disease. If necessary, contact your local Cooperative Extension Office for more information on registered fungicides which are labeled for use on peony.

BRONZE BIRCH BORER (*Agrillus anxius* Gory)



Bronze Birch Borer

The adult bronze birch borer, *A. anxius*, is a slender beetle about .94 – 1.27 cm (3/8 – 1/2 in) long. The larvae are about .06 – 3.17 cm (1/16 – 1 1/4 in) long and .24 cm (3/32 in) wide.

Adults emerge leaving a D-shaped hole in the bark of the birch. They feed on leaf margins; they mate and lay eggs, usually on the sunny side of birch trees. Mated females lay eggs in crevices in the bark near branch scars, under loose outer bark flakes or around wound areas. The eggs are creamy white to yellowish. The larvae bore through the egg shell directly into the bark in about 10 to 14 days. The larvae bore in the cambium layer or occasionally into sapwood. The larvae tunnel and feed laterally around a branch in a zigzag manner, girdling an upper branch which

then suddenly wilts and dies. Reinfestation results in most of the branches dying from the top down, and when the trunk is girdled the tree dies. Many larvae may overwinter and take an additional year before pupation and emergence as an adult.

MANAGEMENT

Birches prefer shady, cool and moist wooded areas. Providing adequate fertilization and management of aphids and leaf miners (with predators or parasites) will help keep the trees vigorous and better able to withstand the *A. anxius*. Preventive surface insecticide sprays applied to the tree bark before eggs are laid may provide a barrier to larvae attacking the tree. Thorough drenching of the trunk and larger than 3.81 cm (1 1/2 in) diameter branches will be necessary. Degree day (heat unit) models for *A. anxius* have been developed for timing of treatments to anticipate egg laying and larvae emergence.

Pruning out wilting or dead upper branches may help prevent reinfestation of the affected birch tree. *Betula pendula*, *B. papyrifera*, and *B. populifolia* are very susceptible to attack by *A. anxius*. Birches that are in a weakened condition from repeated attack, defoliation, adverse weather or old age are much more susceptible to *A. anxius* boring. The larvae do not survive in healthy trees. Chlorotic leaves and sparse foliage evident in the upper crown may be accompanied by increased adventitious growth in the lower crown. If such growth develops, it will be accompanied by twig die-back in the upper crown. Lumpy bark is another sign of attack by *A. anxius*.

The monarch birch, *B. maximowicziana*, *B. platyphyla* var. *japonica* and *B. nigra* are said to be more tolerant or resistant to *A. anxius*. Woodpeckers and a parasite (*Phasganophora sulcata* Westwood) are natural control agents. Vigorously growing birch trees are less likely to be damaged. Resistant birch species should be cultivated as replacements if the present trees succumb to *A. anxius*.

COTTONWOOD LEAF BEETLE & ASPEN SKELETONIZER



The cottonwood leaf beetle *Chrysomela scripta*, occurs throughout the United States and feeds primarily on the eastern cottonwood. Poplars, willows and alders are secondary hosts. These beetles are serious defoliators of cottonwoods. Continuing defoliation and twig damage through the summer reduces seedling growth and vigor.

The adults hibernate under bark, litter and debris. They emerge in early spring and feed on unfolding leaves and tender buds. In just a few days, females begin to lay eggs in clusters on the underside of leaves. When eggs hatch, larvae begin to feed on the underside of the foliage. Older larvae feed separately and consume the entire leaf. The pupae attach themselves to leaves and bark or to weeds and grass beneath the trees.

Cottonwood Leaf Beetle

Look for ragged foliage near branch ends. Some leaves will have brown patches where young larvae have skeletonized the leaves. Other leaves will have only their veins and midribs remaining. Heavy damage results in dead, black terminals with most of the leaf tissue being consumed. Also look for black frass on leaves.

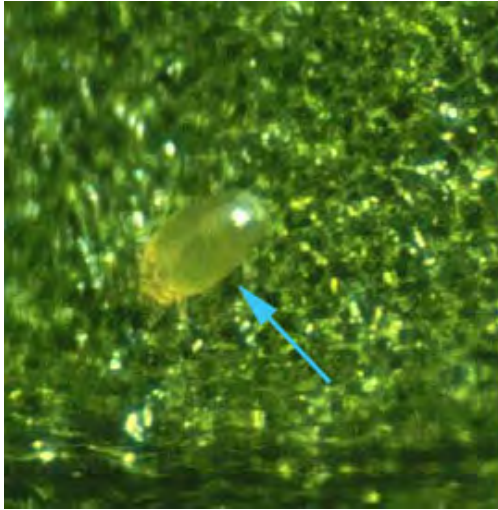
The aspen skeletonizer feeds on aspen, black cottonwood, poplar, paper birch, red alder and willow. Look for skeletonized leaves with intact veins, groups of grublike larvae with well-developed legs on the thorax. These beetles prefer young foliage and high populations may kill shoots and cause deformed growth. Young trees may be killed.

Management: Employ sanitation practices around trees to either destroy the hibernating beetles directly or to expose them to winter temperatures. If necessary, contact your local Cooperative Extension Office for information on effective, low-risk insecticides that are registered for these insects.



Aspen Skeletonizer

CYCLAMEN MITE OF DELPHINIUM *Steneotarsonemus pallidus* (Banks)



Cyclamen Mite

eggs shells are delicate and can often collapse before larvae are hatched. The eggs require about 11 days to hatch. They are highly active for one week, after which they enter a quiet stage for a few days, then molt to the adult stage.

Management: Cyclamen mites are very sensitive to heat. They are more difficult to manage in winter. They are difficult to control by means of chemicals because the mite is resistant to many of the commercial insecticides, and because of its location within unfolded leaves on the plant.

Two natural predatory mites, *Typhlodromus bellinus* and *Typhlodromus reticulatus* are efficient predators, but seldom provide economic control. The six-spotted thrips can also be an important natural enemy when present.

The cyclamen mite was first reported in the U.S. about 1900. They are extremely tiny and not visible to the naked eye. When mature, the mite measures only about .3 mm (.001 in) long, and are pinkish orange and shiny. The hind legs are thread-like in the female, and like pincers in the male. In low populations, the mites are usually found along the midvein of young unfolded leaves. In high populations, the mites can be found anywhere on plant tissue.

The cyclamen mite requires a high temperature and humidity environment and is more of a pest in greenhouses. Outdoors, cyclamen mites survive by residing within the protected folded leaves of plants. Female mites lay two or three eggs each day. The

GRAPE BERRY MOTH *Endopiza viteana*



Grape Berry Moth

The grape berry moth is native to eastern North America where it originally occurred on wild grapes. It has now become a major pest of cultivated grapes, and its present range is east of the Rocky Mountains. The grape berry moth feeds only on grapes, and has up to two generations per year. Damage results from larvae feeding on flower clusters and fruit.

Grape berry moth overwinters as pupae in leaf litter on the ground and emerges in mid- to late May. Emergence peaks in mid-June and continues until mid-July. The moth is small (.64 cm [1/4 in] long) and has an inconspicuous brown appearance. They are most active from late afternoon until after dusk. Eggs are laid singly on buds, stems or newly-formed fruit. Depending on temperature, eggs hatch after four to eight days. The newly hatched larva is creamy white with a dark brown head. As it grows, its body becomes greenish and eventually turns purple.

Damage can be quite serious since a single larva can destroy a dozen or so potential berries by feeding on buds, flowers and the newly set fruit. Larval feeding reduces yield and contaminates the crop. Even more importantly, feeding by grape berry moth larvae creates infection for rot organisms and invites attack by *Drosophila* flies.

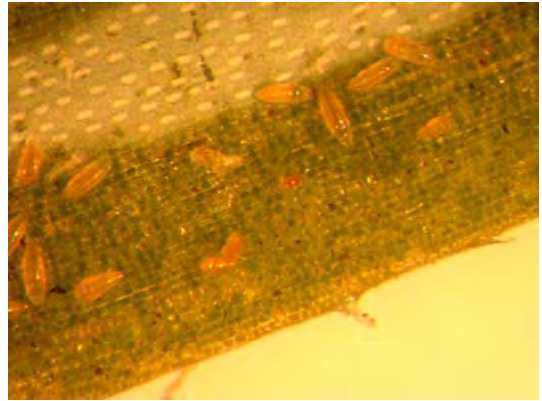
Monitoring: Infestations can vary greatly from year to year so insect monitoring for damage provides guidance on the need for management measures. Damage to grape flower clusters can first be observed during the early bloom period. Pheromone traps can be used to monitor the timing of the first adult berry moth emergence. Traps should be installed when shoot growth reaches about 30.48 cm (12 in). Check traps twice a week for presence of the grape berry moth.

Management: In light infestations, injured fruit can be removed by hand. Some measure of control can be achieved by gathering the leaves with the pupal cells in the fall and destroying them. Covering leaves containing cocoons with a layer of compact soil will prevent emergence. If infestations are heavy and insecticides are desired, contact the local Cooperative Extension Office for recommendations on which low-risk insecticides are registered for use.

HEMLOCK RUST MITE *Nalepella tsugifoliae* Keifer

The hemlock rust mite belongs to a group of microscopic mites. The adult is not visible to the naked eye. A hand lens is needed to glimpse the mite. The orange to pink adult is about .25 mm (.01 in) long.

The overwintering eggs hatch in early to mid-March. Populations of this mite build quickly in early spring with most eggs hatching within the first week. As this species is a cool weather pest, populations decrease in the summer and then increase again in the fall before overwintering eggs are deposited in November. Nymphs emerge from the eggs headfirst and immediately move to healthy tissue to feed. The mite feeds on the upper surface of the needle before moving to the undersurface. The first generation eggs are deposited here.



Hemlock Rust Mite

Damage caused by the hemlock rust mite appears as small silvery spots that are evident along the outer edge of the needle. Premature needle drop will result if the population is not managed.

Management: In winter, look for white to amber-colored eggs along the base of the needle where it lies flat against the stem. These mites are not susceptible to management with the standard miticides. Consult the local Cooperative Extension Office for recommendations on what low-risk materials are suitable for management of these pests. *Neoseiulus cucumeris*, a predatory mite, may feed on rust mites. Check for suppliers of beneficial organisms.

HOLLYHOCK RUST *Puccinia malvacearum*



Hollyhock Rust

This rust disease, which can result in serious injury to hollyhocks, is found nearly everywhere they are grown. It also occurs on mallow (*Malva rotundifolia*), a common weed, and can serve as a disease reservoir for the hollyhocks. The rust is caused by the fungus *Puccinia malvacearum* and only has one infectious stage and is not known to have any alternate hosts.

The leaves may develop yellow spots; however, the most obvious symptoms are the orange and brown pustules on the undersides of the leaves. This is a characteristic sign of a

rust infection. They can also form on the upper side of the leaves, on stems and on green flower parts. The rust increases in severity as the summer progresses, killing most of the leaves on infected plants by early fall.

Large numbers of spores develop, which are carried by rain and air currents to nearby healthy plant hosts to cause new infections. The fungus overwinters in infected plant debris. In the spring, new spores are formed on infected plant debris which can cause infection on newly emerging leaves.

Management: Cut all hollyhock stalks back to ground level in the fall and thoroughly collect all leaves and other above-ground plant parts and destroy them. This cleanup is vital to remove as much fungus as possible before spring. Avoid crowding plants and only water early in the day so the plants will dry quickly. If mallow is found in the area, it should be removed and destroyed. When plants are dry, pick off and destroy any leaves or other plant parts as soon as signs of rust infection are noticed.

If necessary, fungicide treatments can be done in the spring when the first leaves are expanding. Neem oil is a low-risk product which can be used. Contact the local Cooperative Extension Office for products registered for hollyhock rust in New Hampshire.

HONEYLOCUST PLANT BUG *Diaphnocoris chlorionis* (Say)

The honeylocust plant bug has been known from the foliage of honeylocust from Quebec to Indiana for over a century. It did not become a pest until well after the introduction of the thornless cultivars into the ornamental/shade tree market in the 1950s and 1960s. In more recent decades, the plant bug has been damaging and defoliating honeylocust in the eastern states.



Honeylocust Plant Bug

The nymphs and adults of the plant bug suck juices from the leaves, causing discolored, distorted and stunted foliage early in the season. The most serious damage occurs at the time of leaf expansion when the bugs are hidden. Adult females lay clusters of eggs in June under the bark of young twigs, where they remain hidden until the following spring. Plant bugs have only one generation per year. Adults are about .3 cm (1/8 in) when mature and both nymphs and adults are green to yellow green. The adults are rarely seen after late July.

Trees grown in exposed, sunny locations are more prone to plant bug attack. Honeylocust plant bugs damage individual leaves, but generally do not threaten the health of mature trees.

Management: Both nymphs and adults can easily escape detection because their color is closely matched to that of new growth. Pruning following defoliation and twig mortality should reduce honeylocust plant bug populations the following year. Insecticides can be used to protect the appearance of infested trees. They should be used judiciously as they kill natural enemies as well as the plant bugs. Low-risk products such as Pyrethrins have low toxicity, are effective, and have little impact on many beneficial insects including natural enemies. Use insecticides carefully to preserve these natural enemies for good, long-term management.

HONEYLOCUST POD GALL MIDGE *Dasineura gleditchiae* (Osten Sacken)



Honeylocust Pod Gall Midge

The larvae of the honeylocust pod gall midge feed on newly-emerging leaves, prohibiting them from developing normally. There are several generations each year. The adult flies become active at bud break, laying their eggs in developing leaflets. The larvae initiate pod gall development on leaflets, which turn brown and drop from the tree. New adults emerge from the galls, laying eggs of subsequent generations. Infestations can occasionally be severe enough to temporarily destroy all new growth. Leaflets that have already

expanded are not injured by the insect. All common honeylocust varieties appear to be susceptible.

Monitoring: Look for the development of pod galls as leaflets expand.

Management: Destruction of pod galls that fall to the ground can reduce the midge population. Natural controls include severe weather and a small parasitic wasp that attacks young midge larvae. Check with beneficial insectaries for parasitic wasps. Heavy midge infestations often collapse when new growth ceases and the tree is no longer attractive to the egg-laying adult midges. In the absence of suitable egg-laying sites, the adult midges apparently go into an inactive stage, renewing activity the following spring. Chemical controls have been only moderately effective.

HONEYLOCUST SPIDER MITES *Platytetranychus multidigituli*

Adult mites that have overwintered are less than 1 mm (.04 in) long and orange. Adults that mature in the summer are pale yellow to green. Eggs are deposited in the spring and hatch in early to mid-June. Populations can develop quickly as the length of a generation is only four days in mid-summer and 11 days in cooler temperatures. There are several generations a year.

Adult females overwinter in bark cracks or under bud scales. In lighter infestations, the upper surface of leaves appears to be stippled white or yellow. Heavy infestations can cause all the foliage of a tree to turn brown and die. Injured leaves often drop prematurely. Damage is primarily aesthetic.



**Honeylocust Spider
Mites**

Monitoring: Eggs hatch at honeylocust bud break. A small hand lens is helpful in monitoring mites. Look for adult females in winter around bark cracks or under bud scales. Check for mites throughout the growing season at the base of leaflets, on the underside of leaves, and look for signs of leaf browning.

Management: Large overwintering populations can be treated with a dormant oil spray. The oil needs to be applied to both the trunk and the crown. Summer populations can be controlled by a horticultural oil or insecticidal soap. Predators of mites include minute pirate bugs, lacewings, predatory mites, lady beetles and predatory midges. The use of conventional pesticides is not recommended as they can destroy the natural enemies of the mites.

JAPANESE BEETLES *Popillia japonica* Newman



Japanese Beetle Adults

The Japanese beetle is a major pest of urban ornamentals. The beetle occurs in much of the United States.

Adult beetles are .94 cm (3/8 in) long, metallic green, with hard copper-brown wing covers. Five small tufts project from under the wing covers on each side and a sixth pair at the tip of the abdomen. Adults emerge from the ground in late May or early June. Individual beetles live about 30 – 45 days with activity concentrated over a four to six week period. Beetle numbers begin to decline in late July.

Japanese beetles feed on about 300 species of plants, ranging from roses to poison ivy. Odor and location in direct sun are important in host plant selection. The beetles usually feed in groups, starting at the top of a plant and working down. While a single beetle doesn't eat much, group feeding causes severe damage. Adults feed on the upper surface of foliage chewing tissue between the veins. This gives leaves a skeletonized appearance. Japanese beetles can fly up to five miles, but one to two miles is average. They usually make only short flights as they move about to feed.

MANAGEMENT

Management of the beetle grubs in turf grass is the most effective and efficient approach. The bacterium, *Bacillus popilliae*, is effective on Japanese beetle grubs in turf. It may take a few seasons to achieve lasting management. The use of parasitic nematodes (*Heterorhabditis bacteriophora*) in turf will also reduce grub populations. Apply nematodes while it is raining to get good penetration into the turf (see the Pest Profile on white grubs.). Direct spray applications of insecticidal soap kills adult Japanese beetles on contact, but does not provide any residual protection.

The hard body of the Japanese beetle may make them unattractive to many predators such as birds. Hand collecting can be a control option to protect valuable plants when beetle activity is low. When beetles are removed from a plant daily by hand, only about half as many are attracted to that plant compared to those on which beetles are allowed to accumulate.

Commercially available traps attract the beetles with two types of bait. One mimics the scent of female beetles and is only attractive to males. The other bait is a food lure that attracts both sexes. This is a powerful attractant that can draw thousands of beetles into traps in a day. If traps are used, place them near turf well away from gardens and landscape plants, and check (and empty) them daily.

LILAC LEAFMINER MOTH *Gracillaria syringella* (Fabricus)

The lilac leafminer moth is an introduced insect that feeds primarily on the leaves of lilac and green ash trees. The first sign of damage is a small linear tunnel on the underside of the leaf surface. As the larva grow inside the leaf, light green to brown blotches will appear on the upper surface of the leaves. The blotches develop in response to the larva eating the inner layer of the leaf. Gradually the blotches grow larger, turn a darker brown and become brittle. The larva then exits the inner leaf surface, rolls the leaf up and begins to feed on the upper leaf surface within the curled portion.



Lilac Leafminer Moth

The adult lilac leafminer moth is slender, grayish-brown and about 6 mm (.24 in) in length. The eggs are very tiny and transparent, and are not usually noticed. Small green larvae emerge from the eggs. As they mature, they change to a pale yellow color. At maturity, the larvae will appear flat and reach approximately 8 mm (.32 in) in length. The larvae will then pupate in the soil within a small white cocoon.

Management: The lilac leafminer is best managed by simply removing the leaves as soon as damage is noticed. Collect and dispose of leaves and leaf debris in the area.

MIMOSA WEBWORM *Homadaula anisocentra*



Mimosa Webworm Larvae

Larvae of this insect are grayish to dark brown, sometimes tinged with pink. They are 1.27 – 2.54 cm (1/2 – 1 in) long. Five white stripes run the length of the body. The larvae are extremely active and drop on silk strands when disturbed. The adult moth may seldom be seen, but has about a 1.27 cm (1/2 in) wingspan. Wings are gray with a silver sheen and black dots.

The larvae feed on the leaf surfaces of the mimosa and honeylocust trees. The foliage is usually skeletonized. Leaves die and turn dull gray on mimosa and brown on honeylocust. Leaves and

flowers are webbed together as larvae feed and develop. Usually the entire tree is involved with larvae scattered throughout the foliage. Repeated attacks seriously weaken trees, occasionally leading to the death of some trees.

Moths appear in June and lay eggs. The larvae feed within a web spun over flowers and leaves. In midsummer, larvae descend to the ground on silken threads and spin cocoons in cracks in bark or in ground cover.

Management: Since many eggs are laid initially and young larvae begin to feed immediately, trees should be watched for the earliest signs of feeding in June. Larvae are more difficult to control when larger and webbing is in existence. Application of *Bacillus thuringiensis* can effectively manage mimosa webworms if it is applied when the larvae are small. Since the adults may emerge over an extended period, several applications may be necessary.

SLUGS

Several species of slugs are frequently damaging, including the gray garden slug (*Agriolimax reticulatum*), the banded slug (*Limax marginatus*), the tawny slug (*Limax flavus*), and the greenhouse slug (*Milax gagates*). Slugs move by gliding along on a muscular “foot.” This muscle constantly secretes mucus which dries to form the “slime trail” that signals the presence of the pest. Slugs reach maturity after about three to six months, depending on species, and lay clear oval to round eggs in batches of three to 40 under leaves, in soil cracks and other protected areas.



Slug

Slugs are most active at night and on cloudy days. During cold weather, slugs hibernate in the topsoil. They feed on a variety of living plants as well as on decaying plant matter. On plants they chew irregular holes with smooth edges in leaves and flowers. They can also chew fruit and young plant bark.

Management: A slug management program relies on a combination of methods. If possible, eliminate areas where slugs can hide during the day; i.e., boards, stones, debris, weedy areas around tree trunks and dense ground covers. Handpicking can be effective if done on a regular basis. Several types of barriers will keep slugs out of planting beds. The easiest to maintain are those made with copper flashing and screen. Copper barriers are effective because it is thought that the copper reacts with the slime that the slug secretes, causing a flow of electricity. Copper bands can also be placed around trees

Slugs have many natural enemies, including ground beetles, pathogens, snakes, toads, turtles and birds, but most are rarely effective enough to provide satisfactory control.

Sluggo is a registered slug bait containing iron phosphate. This is a low-risk choice for an IPM program as it is relatively innocuous for use around animals, birds, fish, children and wildlife. Ingestion of the iron phosphate bait will cause slugs to cease feeding, although it may take a few days for the slugs to die. Iron phosphate bait can be scattered on lawns or on the soil around trees or ornamental plantings.

TREEHOPPER *Micrutalis calva* (Say)



This insect feeds on both honeylocust and black locust, as well as other plant species. It is one of the smallest treehoppers in the United States, appearing in honeylocust trees about the same time as the honeylocust plant bug. All of the nymphal stages of *M. calva* feed on leaflets and petioles. The biology of this insect has not been studied much. There are probably two generations per year. Overwintering eggs are laid in twigs of honeylocust in late October.

Treehopper

The treehoppers in general are members of a family of winged insects remarkable for their curious shapes.

Many treehoppers resemble small thorns and are protectively colored in green or brown. The adults are usually under 1.2 cm (1/2 in) long and can jump from one place to another. Females lay their eggs in slits in bark, which sometimes damages the tree. Most species of treehoppers are not considered to be important pests.

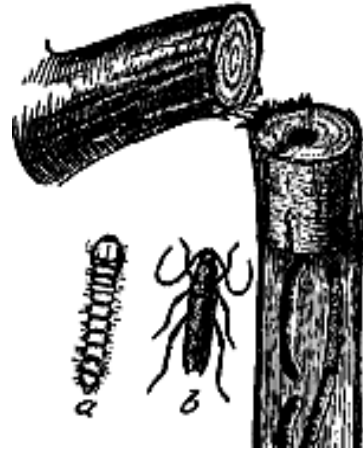
MANAGEMENT

Very little information is available on which to base management recommendations for treehoppers. Ordinarily this species does not do enough damage to justify management measures.

TWIG PRUNER *Elaphidionoides villosus* (F.)

Adult twig pruners are longhorned beetles which are 11 – 18 mm (.43 - .71 in) long, slender and brown with two spines on the tip of each elytra. Their antennae are longer than the body. Mature larvae are about 25 mm (.98 in) long and are identifiable by their lemon-colored hairs on the prothorax.

Adults emerge in late spring and eggs are deposited into slits in the bark at twig tips and leaf axils. Larvae feed beneath the bark and then bore down the center of the stem until late summer. Host plants are hardwoods such as elm, hackberry, hickory, locust, maple, oaks, pecan, sweetgum and walnut. There is one generation per year. Pupae overwinter in twigs on the ground.



Twig Pruner

Larvae sever twigs by making circular cuts from the center outward under the bark, breaking off twigs. Heavily infested trees may be seriously injured. The appearance of trees may be affected, but trees are not killed.

MONITORING

Look under trees in August and September for fallen twigs and branches, and cut open a sample to detect larval tunnels and larvae preparing to pupate and overwinter.

MANAGEMENT

Since the larvae are in the twigs when they fall from the tree, gathering and burning the girdled twigs is a means of preventing further damage. This can be done in the fall and in the spring before the adults emerge. There is no insecticide specifically labeled to control this minor pest. Three hymenopterous parasitoids are recorded, but the degree of control is unknown.

FALL WEBWORM *Hyphantria cunea* (Drury)



Fall Webworm

The fall webworm is a native of North America and Mexico. Depending upon location, there can be one to four generations per year. Webworms enclose leaves and small branches in their light gray, silken webs. The fall webworm is usually of only minor economic importance as a forest pest. However, shade trees and ornamentals can be heavily defoliated and the presence of the large, unsightly webs can make them aesthetically distracting. Persistent infestations of individual trees can cause limb and branch dieback.

The fall webworm is known to feed on over 100 species of forest and shade trees, including American elm, hickory, maples, fruit trees, pecan and walnut in the eastern U.S. Adult moths have a wingspan of between 35 – 42 mm (1.4 – 1.7 in). They appear mostly from May to August and deposit their eggs in hair-covered masses of several hundred each, usually on the underside of host leaves. Larvae are usually pale yellow-green. Full grown larvae may reach a length of 2.54 cm (1 in). Newly hatched larvae immediately spin a silken web over the foliage on which they feed. As they grow, they enlarge the web to enclose more foliage. On heavily infested trees, several branches may be enclosed in webs. Pupation occurs in thin cocoons usually spun in the debris or just beneath the soil.

Management: Though the webs are unsightly, damage to most trees is considered to be minor. Small nests can be pruned out of small to medium trees. Monitor trees early to detect the nests when only several leaves are involved. These small nests can be easily crushed. Encourage parasites and predators. Over 80 species of parasites and predators have been identified. Yellow jackets, paper nest wasps, birds, predatory stink bugs, and parasitic flies and wasps are the most important. Apply *Bacillus thuringiensis*. It is quite effective against fall webworms if applied when the larvae are small. Apply thoroughly to cover leaves next to nests. As these leaves are incorporated into the nest and eaten, the *Bt* will be ingested.

WILLOW LEAF BEETLE *Plagioder a versicolora*

Adult willow leaf beetles are from .3 - .64 cm (1/8 – 1/4 in) long, oval, and shiny black to greenish blue. Larvae are black and about .64 cm (1/4 in) long at maturity. Eggs are shiny, pale yellow and laid in irregular groups. Several varieties of willow and poplar are susceptible.



Willow Leaf Beetle

Beetles overwinter as adults in protected locations near the tree trunk. They emerge in early to mid-May; begin producing feeding damage, and start egg laying activity. Eggs hatch a few days after they are laid and young larvae feed immediately on leaf undersides, skeletonizing the leaf surface. Larvae feed on both upper and lower leaf surfaces as they mature and transform into pupae on leaves about three to four weeks after egg hatch. Several generations may be produced in a single season.

Management: Although damage may be unsightly, it is usually not fatal to the tree. Natural enemies, including several parasites, exist and one pupal parasite looks to be especially effective in reducing populations of this insect. With some ornamental pests, such as this one, it is a judgment decision whether to engage in some type of control measure or to let nature take its course. If management of the pest is desired, *Bacillus thuringiensis* var. *tenebrionis* (*Btt*), insecticidal soap or Spinosad may be applied. These pesticides are low-risk and will not have an effect on natural enemies or pollinators. *Btt* is only effective for control of larvae.

AUTUMN OLIVE *Eleagnus umbellata* Thumb.

Autumn olive is a medium to large shrub in the Oleaster family often reaching a height of 6.1 m (20 ft). The leaves are generally oval in shape, approximately 2.54 – 7.62 cm (1 – 3 in) long. The upper surface of the leaves is dark green in color, while the underneath side is covered with silvery scales. Small light yellow flowers bloom in late April and May after the first leaves have appeared. Small fleshy fruits range in color from pink to red.



Autumn Olive

Autumn olive was introduced into the United States in 1830 from Asia, and is found from Maine south to Virginia, and west to Wisconsin. In the eastern U.S., autumn olive has been planted for revegetation of disturbed areas. It is rarely encountered in dense forests or in very wet sites. It has nitrogen-fixing root nodules which allow it to thrive in poor soils. Autumn olive is drought tolerant and may invade grasslands and sparse woodlands. Birds forage on its fruits and contribute to seed dispersal.

Autumn olive is a very troublesome invasive species. In addition to its prolific fruiting, seed dispersal by birds, rapid growth and ability to thrive in poor soils, autumn olive resprouts vigorously after cutting or burning. It creates heavy shade which suppresses plants that require direct sunlight.

Management: Young seedlings can be hand-pulled in early spring when the root system is small enough to allow total removal. It is easily seen in early spring because its leaves appear when most native vegetation is still dormant. Cutting the plant off at the main stem and wiping or spraying each stump with Glyphosate or Triclopyr is an effective control measure. Repeated pruning of established plants without cut-stump herbicide application is not effective for control. Each regrowth results in a thicker stem base and denser branches. Burning during the dormant season also results in vigorous resprouting.

BLACK LOCUST *Robinia pseudoacacia* L.

Black locust is a fast growing tree that can reach 12.2 – 30.48 m (40 – 100 ft) in height at maturity. Its native range is from the lower slopes of the Appalachian Mountains throughout the southeastern United States; however, black locust has been planted in many climates and is naturalized through the U.S.

The bark of the mature tree is dark brown and deeply furrowed with flat-topped ridges, while the young saplings are smooth and green. They are easily identified by long paired thorns. Fragrant white flowers appear in May and June. The black locust prefers full sun and well drained soils, and is commonly found in disturbed areas. Because of its rapid growth, the black locust has been promoted by government agencies and nurseries as a desirable landscape plant. It has been planted extensively for its nitrogen fixing abilities, as a source of nectar for honeybees, and for fence posts and hardwood lumber.



Black Locust

The black locust reproduces vigorously by root suckering and stump sprouting to form groves of trees connected by a common root system. Physical damage to roots and stems increases suckering and sprouting, making management difficult. Even though the black locust produces many seeds, they seldom germinate.

Black locust poses a serious threat to native vegetation outside of its historic range. Once introduced to an area, black locust expands readily into areas where their shade reduces competition from other plants.

Management: Mowing and burning are effective in reducing the further spread of young shoots from a parent tree. Cutting alone is ineffective. Using Glyphosate or Triclopyr to cut stumps provides good control. However, monitoring is necessary as resprouting and suckering may require follow-up treatment even several years after the herbicide treatments.

BLACK SWALLOW-WORT *Vincetoxicum nigrum*



Black Swallow-wort

Black swallow-wort vines twine .91 – 1.83 m (3 – 6 ft) high, often smothering nearby vegetation. It is also called Dog-strangling vine and climbing milkweed. The leaves are 6 – 12.70 cm (2 – 5 in) long, opposite, toothless, oval-shaped and dark green with smooth, shiny surfaces. Flowers are dark purple and each of the five pointed petals are triangular and covered with downy white hairs. Ripe seeds are wind-dispersed on silky filaments. Roots are fleshy with a rhizomatous crown just below the soil surface.

Black swallow-wort is native through Europe and Asia. It was introduced into North America as a horticultural plant that quickly escaped cultivation. It is common throughout the northeastern U.S. Swallow-wort is an aggressive exotic species. It readily invades disturbed sites and is commonly found in old fields, pastures, fence rows and road ditches. It has also been found invading managed landscapes.

Management: Digging up the root crowns is effective but the whole crown must be removed. Pulling the plants by hand generally leads to resprouting but can prevent seed production, especially if repeated during the growing season. A less effective method is pod picking, which also limits seed production, but does little damage to the existing population. Mowing is best for preventing seed production. Mow frequently (one to two visits per season) just as the pods are beginning to form.

The use of a Triclopyr-based herbicide (Garlon 4) is an option in grassy areas. Repeated herbicide applications will most likely be necessary in vigorous stands. Cut-stem applications are recommended for small infestations or if nearby desirable vegetation might be adversely affected. Burning and grazing do not appear to be effective.

COMMON & GLOSSY BUCKTHORN



Common Buckthorn

Common buckthorn has smooth, deeply veined, oval leaves with toothed margins. Glossy buckthorn has gray-brown bark and lightly colored lenticels, which give the bark a speckled appearance. Its leaves are shiny on the upper surface, oval shaped and slightly wavy.

Both common and glossy buckthorn have a wide habitat tolerance, rapid growth rates and extensive root systems. They both produce abundant flowers and fruits throughout the growing season. Seeds are widely dispersed by birds. Once established, these species aggressively invade natural areas and form dense thickets displacing native species. They leaf out very early in the growing season and keep their leaves late into the fall, helping to shade out native trees and shrubs.

Management: Prescribed burning has been used to control buckthorns in some natural areas. Fire will top kill stems, however, resprouting will occur and seed germination may increase. Hand pulling may be successful in small infestations, although several seasons may be required as resprouting will occur if part of the root is left behind. This method also disturbs the soil, increasing seed germination. Repeated mowing is also effective in maintaining open areas and preventing seedling establishment. Application of Glyphosate or Triclopyr to cut stumps during the growing season and in warm days of winter has proven to be effective. A foliar application of Triclopyr in dense thickets may be effective in the spring and fall. Biological controls are not available, however, studies of possible fungal and insect pests are ongoing.

A portion of this information was taken from a paper by Jil M. Swearingen, U.S. National Park Service, Washington, DC.

Common and glossy buckthorn were introduced to North America from Eurasia as ornamental shrubs for fence rows and wildlife habitat, and are still used in landscaping. These species are distributed throughout the northeast and north central U.S.

Both common and glossy buckthorn are woody shrubs or small trees that can reach up to 6.05 m (20 ft) in height. Cutting the stems of either species reveals a distinctive yellow sapwood and pink to orange heartwood. Common buckthorn is primarily an invader of upland sites including open woods, woodland edges and open fields. Glossy buckthorn typically invades wetlands including swamps, bogs, fens and wet meadows, but also occurs in upland habitats. Both species are capable of growing in full sun as well as heavily shaded areas.

Plants flower from late May until the first frost and fruits ripen from early July to September. Common



Glossy Buckthorn

GARLIC MUSTARD *Alliaria petiolata* [Bieb] Cavara & Grande



Garlic Mustard Rosette

Garlic mustard (an invasive plant from Europe) is a cool season biennial herb with stalked, triangular to heart-shaped, coarsely toothed leaves that give off an odor of garlic when crushed. First-year plants appear as a rosette of green leaves close to the ground. Rosettes remain green through the winter and develop into mature flowering plants the following spring.

Flowering plants of garlic mustard reach from .61 - .91 m (2 – 3 ½ ft) in height and produce buttonlike clusters of small white flowers, each with four petals in the shape of a cross.

Recognition of garlic mustard is critical. Several white-flowered native plants, including toothworts (*Dentaria*), sweet cicely (*Osmorhiza claytonii*), and early saxifrage (*Saxifraga virginica*), occur alongside garlic mustard and may be mistaken for it.

Beginning in May in the mid-Atlantic Coast Plain region, seeds are produced in erect, slender pods and become shiny black when mature. By late June, when most garlic mustard plants have died, they can be recognized only by the erect stalks of dry, pale brown seedpods that remain, and may hold viable seed, through the summer.

Garlic mustard poses a severe threat to native plants and animals in forest communities. Many native wildflowers that complete their life cycles in the springtime (e.g., spring beauty, wild ginger, bloodroot, Dutchman's breeches, hepatica, toothwort, and trilliums) occur in the same habitat as garlic mustard. Once introduced to an area, garlic mustard outcompetes native plants by aggressively monopolizing light, moisture, nutrients, soil and space. Wildlife species that depend on these early plants for their foliage, pollen, nectar, fruits, seeds and roots, are deprived of these essential food sources when garlic mustard replaces them.



Garlic Mustard in Bloom

Garlic mustard also poses a threat to one of our rare native insects, the West Virginia white butterfly (*Pieris virginiensis*). Several species of spring wildflowers known as "toothwort" (*Dentaria*), also in the mustard family, are the primary food source for the caterpillar stage of this butterfly. Garlic mustard is causing local extirpations of the toothwort, and chemicals in garlic mustard appear to be toxic to the eggs of the butterfly, as evidenced by their failure to hatch when laid on garlic mustard plants.

Garlic mustard is found from eastern Canada, south to Virginia and as far west as Kansas and Nebraska. Garlic mustard frequently occurs in moist, shaded soil of river floodplains, forests, roadsides, edges of woods, trails edges and forest openings. Disturbed areas are most susceptible

to rapid invasion and dominance. Though invasive under a wide range of light and soil conditions, garlic mustard is associated with calcareous soils and does not tolerate high acidity.

After spending the first half of its two-year life cycle as a rosette of leaves, garlic mustard plants develop rapidly the following spring into mature plants that flower, produce seed and die by late June. Seeds are produced in erect, slender, four-sided pods, called siliques, beginning in May. Siliques become tan and papery as they mature and contain shiny black seeds in a row. By late June, most of the leaves have faded away and garlic mustard plants can be recognized only by the dead and dying stalks of dry, pale brown seedpods that may remain and hold viable seed throughout the summer.



Garlic Mustard Seed Pods

A single plant can produce thousands of seeds, which scatter as much as several meters from the parent plant. Garlic mustard flowers either self-fertilize or are cross-pollinated by a variety of insects. Self-fertilized seed is genetically identical to the parent plant, enhancing its ability to colonize an area. Although water may transport seeds of garlic mustard, they do not float well and are probably not carried far by wind. Long distance dispersal is most likely aided by human activities and wildlife. Additionally, because white-tailed deer prefer native plants to garlic mustard, large deer populations may help to expand it by removing competing native plants and exposing the soil and seedbed through trampling.

Management: Because the seeds of garlic can remain viable in the soil for five years or more, effective management requires a long term commitment. The goal is to prevent seed production until the stored seed is exhausted. Hand removal of plants is possible for light infestations and when desirable native species co-occur. Care must be taken to remove the plant with its entire root system because new plants can sprout from root fragments. This is best achieved when the soil is moist, by grasping low and firmly on the plant and tugging gently until the main root loosens from the soil and the entire plant pulls out. Pulled plants should be removed from site, especially if flowers are present.

For larger infestations of garlic mustard, or when hand-pulling is not practical, flowering stems can be cut at ground level or within several inches of the ground, to prevent seed production. If stems are cut too high, the plant may produce additional flowers at leaf axils. Once seedpods are present, but before the seeds have matured or scattered, the stalks can be clipped, bagged and removed from the site to help prevent continued buildup of seed stores. This can be done through much of the summer.

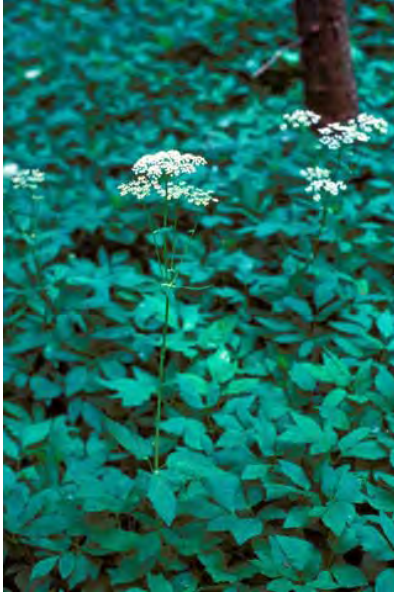
For very heavy infestations, where the risk to desirable plant species is minimal, application of the non-selective, systemic herbicide Glyphosate (e.g., Roundup) is also effective. Herbicide may be applied at any time of year, including winter (to kill overwintering rosettes), as long as the temperature is above 10°C (50°F) and rain is not expected for about eight hours. Spray shields may be used to better direct herbicide and limit non-intentional drift.

Regardless of the management method employed, annual monitoring is necessary for a period of at least five years to ensure that seed stores of garlic mustard have been exhausted.

Researchers are investigating potential biological control agents for garlic mustard which may greatly improve management. The curculionid weevils *Ceutorhynchus scrobicollis* and *C. constrictus* are being researched for host specificity.

Portions of this document were taken from a paper done by Jil M. Swearingen, U.S. National Park Service, Washington, DC.

GOUTWEED *Aegopodium podagraria* L.



Goutweed

Goutweed was first brought to North America as an ornamental during the early stages of European settlement and was well established in the U.S. by 1863. It is currently known to occur in 29 states in the mid-Atlantic, northeast and northwest, and is reported to be invasive in most of those areas.

Also known as bishop's weed and snow-on-the-mountain, goutweed is an herbaceous perennial plant. Most leaves are basal with the leafstalk attached to an underground rhizome. The leaves can be either medium green or bluish-green with white edges.

Goutweed is an ecologically versatile species. It is found in old gardens and flower beds, around shrubs and other plantings, and in a variety of other disturbed habitats. Goutweed appears to do best in moist soil and in light to moderate shade, but is highly shade-tolerant and capable of invading closed-canopy forests.

Goutweed is an aggressive invasive plant that forms dense patches, displaces native species and greatly reduces species diversity in the ground layer. Goutweed patches inhibit the establishment of conifers and other native tree species as well. It is also sometimes used as a low-maintenance ground cover.

Management: A variety of management methods are available, depending on the extent of the infestation and the amount of time and labor available. Regardless of the method used, the plants should be monitored periodically for a few years. New shoots should be dug up and destroyed. Once control has been achieved, revegetation with native, non-invasive plant materials is recommended. There are no biological control organisms currently available in North America.

Systemic herbicides such as Glyphosate and Triclopyr that are translocated to the roots to kill the entire plant are effective for goutweed control. Cut stump treatment of these herbicides is the recommended method to avoid nontarget adjacent plants.

Small patches of goutweed can be eliminated by persistent hand pulling or digging up of entire plants along with underground stems. Pulled plants can be piled up and allowed to dry for a few days before bagging and disposal. Be careful to pick up all rhizomes which can resprout if left behind. Where appropriate, frequent short mowing may manage or slow the spread of goutweed in landscaped areas, along roadsides and other areas. Preventing goutweed from photosynthesizing in early spring can control the plant by depleting its carbohydrate reserves. Cover the patch with black plastic sheeting when the leaves start to emerge from the ground in the spring, and leave it in place through the summer; or cut all the plants once they have fully leaved out and then cover the area with plastic.

JAPANESE BARBERRY *Berberis thunbergii*



Japanese barberry is a dense, deciduous, spiny shrub that grows .61 – 2.44 m (2 – 8 ft) high. The branches are brown, deeply grooved, somewhat zigzag in form and bear a single very sharp spine at each node. The leaves are small (1.27 – 3.81 cm [$\frac{1}{2}$ – $1\frac{1}{2}$ in] long), oval to spatula-shaped, green, bluish-green, or dark reddish purple. Flowering occurs from mid-April to May in the northeastern U.S. Pale yellow flowers about 0.6 cm ($\frac{1}{4}$ in) across hang in umbrella-shaped clusters of 2 – 4 flowers each along the length of the stem. The fruits are bright red berries about 1 cm ($\frac{1}{3}$ in) long that are borne on narrow stalks. They mature during late summer and fall and persist through the winter.

Japanese barberry may be confused with American barberry (*Berberis canadensis*), a native species of barberry in North America, and common or European barberry (*Berberis vulgaris*) which is an introduced, sometimes invasive plant.

Japanese Barberry Fruit

Japanese barberry forms dense stands in natural habitats including canopy forests, open woodlands, wetlands, pastures, and meadows and alters soil pH, nitrogen levels, and biological activity in the soil. Once established, barberry displaces native plants and reduces wildlife habitat and forage. White-tailed deer avoid browsing barberry, preferring to feed on native plants, giving barberry a competitive advantage. Japanese barberry has been found to raise soil pH (i.e., make it more basic) and reduce the depth of the litter layer in forests.



Japanese Barberry

Japanese barberry has been reported to be invasive in twenty states and the District of Columbia. Due to its ornamental interest, barberry is still widely propagated and sold by nurseries for landscaping purposes in many parts of the U.S.

Barberry is shade tolerant, drought resistant, and adaptable to a variety of open and wooded habitats, wetlands and disturbed areas. It prefers to grow in full sun to part shade but will flower and fruit even in heavy shade.

Japanese barberry was introduced to the U.S. and New England as an ornamental plant in 1875 in the form of seeds sent from Russia to the Arnold Arboretum in Boston, Massachusetts. In 1896, barberry shrubs grown from these seeds were planted at the New York Botanic Garden. Japanese barberry was later promoted as a substitute for common barberry (*Berberis vulgaris*)

which was planted by settlers for hedgerows, dye and jam, and later found to be a host for the black stem grain rust. Because Japanese barberry has been cultivated for ornamental purposes for many years, a number of cultivars exist.

Japanese barberry spreads by seed and by vegetative expansion. Barberry produces large numbers of seeds which have a high germination rate, estimated as high as 90%. Barberry seed is transported to new locations with the help of birds (e.g., turkey and ruffed grouse) and small mammals which eat it. Birds frequently disperse seed while perched on power lines or on trees at forest edges. Vegetative spread is through branches touching the ground that can root to form new plants and root fragments remaining in the soil that can sprout to form new plants.

Management: Do not plant Japanese barberry. Because it is a prolific seed-producer with a high germination rate, prevention of seed production should be a management priority. Because barberry can resprout from root fragments remaining in soil, thorough removal of root portions is important. Manual control works well but may need to be combined with chemical in large or persistent infestations. No biological control organisms are available for this plant.

Treatments using the systemic herbicides Glyphosate (e.g., Roundup) and Triclopyr (e.g., Garlon) have been effective in managing Japanese barberry infestations that are too large for hand pulling. This non-selective herbicide should be used with care to avoid impacting non-target native plants. However, application in late summer during fruiting may be most effective. Triclopyr or Glyphosate may be used on cut stumps or as a basal bark application.

Because Japanese barberry leafs out early, it is easy to identify and begin removal efforts in early spring. Small plants can be pulled by hand, using thick gloves to avoid injury from the spines. The root system is shallow making it easy to pull plants from the ground, and it is important to get the entire root system. The key is to pull when the soil is damp and loose. Young plants can be dug up individually using a hoe or shovel. Hand pulling and using a shovel to remove plants up to about .91 m (3 ft) high is effective if the root system is loosened up around the primary tap root first before digging out the whole plant.

Mechanical removal using a hoe or weed wrench can be very effective and may pose the least threat to non-target species and the general environment at the site. Tools like the weed wrench are helpful for uprooting larger or older shrubs. Shrubs can also be mowed or cut repeatedly. If time does not allow for complete removal of barberry plants at a site, mowing or cutting in late summer prior to seed production is advisable.

To prevent reinfestation by exotic invasive plants, there are many attractive native shrubs available that make great substitutes for Japanese barberry. A few examples include bayberry (*Myrica pensylvanica*), ink-berry (*Ilex glabra*), winterberry (*Ilex verticillata*), arrow-wood (*Viburnum dentatum*), mountain laurel (*Kalmia latifolia*), ninebark (*Physocarpus opulifolius*) and hearts-a-bustin' (*Euonymus americana*).

Some information in this section was taken from a paper by Jil M. Swearingen, U.S. National Park Service, Center for Urban Ecology, Washington, DC.

JAPANESE KNOTWEED *Fallphia japonica*



Japanese Knotweed

Japanese knotweed was introduced to North America in the late 19th century from Japan where it rapidly spread to become a problem weed. It is now regarded as a serious pest which is difficult to manage. Japanese knotweed has spread through most of North America and has been observed as far north as Alaska. It spreads quickly to form dense thickets that exclude native species. The rhizomes can reach 15 – 20 m (50 – 75 ft) in length.

Japanese knotweed grows in a variety of soil types and is found primarily in moist, unshaded areas. Its growth and abundance are decreased in shady sites.

After overwintering, shoots appear from underground rhizomes early in the spring. Rapid growth, which can exceed 8 cm (3 1/2 in) per day, means that full height can exceed 4 m (15 ft) by early summer.

Management: To be effective, Japanese knotweed control will need to be undertaken on a watershed-wide basis as is being done with *Arundo donax* L., an ecologically similar species. Use of Glyphosate or Triclopyr are effective, however, herbicide costs may be prohibitive. Studies are under way at present to find natural enemies for Japanese knotweed, however, surveys have not yet been completed and not much information is yet available. Some species of Lepidoptera and fungal pathogens are being tested and look promising.

JAPANESE TREE LILAC *Syringa reticulata*

Although a lilac, this member of the species is quite different in appearance than those with which gardeners are most familiar. This is a very large shrub or small tree, reaching a height of about 6.1 – 9.15 m (20 – 30 ft) with a 4.57 m (15 ft) spread. The clusters of creamy white flowers are the main ornamental feature of this fragrant, spring-blooming lilac. The tree has been successfully grown in areas where air pollution, poor drainage, compacted soil and/or drought are common.



Japanese Tree Lilac

The Japanese tree lilac has been planted as an ornamental which, however, has escaped cultivation and has become an exotic invasive. A few insects that can be present are lilac borer larvae, lilac leafminer and scales; however, these will not manage this species.

MANAGEMENT

The lilac is usually free of serious disease. Bacterial blight is the most serious on white flowered selections. Phytophthora blight can sometimes kill stems. Leaf blotch causes brown spots. Powdery mildew coats the leaves and Verticillium wilt causes wilting and premature leaf drop. Fungi can cause leaf spots, and bacterial crown gall causes round, warty galls on the stems near the soil line. If bacterial crown gall is found, remove infected plants and do not replant with a sensitive tree in the same spot.

Unwanted young trees can be removed with a Weed Wrench. Mature trees can be cut at ground level and the stump treated with Triclopyr. At SAGA, over 12,000 individual plants have been removed from the park's natural areas.

MORROW'S HONEYSUCKLE *Lonicera morrowii*



Morrow's Honeysuckle

Morrow's honeysuckle was introduced to the United States from Eurasia for use as an ornamental, wildlife cover and for soil erosion control. It ranges from the central Great Plains to southern New England south to North Carolina. Open-grown exotic bush honeysuckles fruit prolifically and are highly attractive to birds. In the eastern U.S., over 20 species of birds feed on the persistent fruits and widely disseminate seeds across the landscape. In established populations, vegetative sprouting also aids in the persistence of these exotic shrubs.

Exotic bush honeysuckles are upright, generally deciduous shrubs that range from 1.83 – 4.57 m (6 – 15 ft) in height. Pairs of fragrant, tubular flowers are borne along the stem with color varying from creamy white to pink. These exotic honeysuckles can rapidly invade and overtake a site, forming a dense shrub layer that crowds and shades out native plant species. They alter habitats by decreasing light availability, deplete soil moisture and nutrients, and release toxic chemicals that prevent other plant species from growing in the vicinity.

Management: Mechanical and chemical methods are the primary means of control. No biological control agents are currently available for this plant. Hand removal of seedlings or small plants may be useful for light infestations, but care should be taken not to disturb the soil any more than necessary. In shaded forest habitats, repeated clippings to ground level during the growing season may result in high mortality. Clipping must be repeated at least once yearly because bush honeysuckles that are cut once and left to grow will often form stands that are more dense and productive than they were prior to cutting.

Well established stands of exotic bush honeysuckles are sometimes best managed by cutting the stems to ground level and painting or spot-spraying the stumps with Glyphosate or Triclopyr. Prescribed burning has shown promise for honeysuckle growing in open habitats. In all instances, control should be initiated prior to seed dispersal (late summer to early fall) to minimize reinvasion of treated habitats.

MULTIFLORA ROSE *Rosa multiflora* Thunb.

Multiflora rose is a thorny, perennial shrub with arching canes. It occurs in most areas in the U.S. and has a wide tolerance for various soil conditions.

Multiflora rose was introduced to the east coast from Japan in 1866 as rootstock for ornamental roses. In the 1930's, the Soil Conservation Service promoted it for use in erosion control and fences to confine livestock. It has also been planted as wildlife cover and in highway median strips for crash barriers.



Multiflora Rose

Multiflora rose reproduces both by seed and by forming new plants that root from the tips of canes that touch the ground. Birds eagerly eat the fruit and serve as the primary dispersers of the seed.

Management: Frequent, repeated cutting or mowing three to six times per growing season for two to four years has been shown to be effective in achieving high mortality of multiflora rose. In some areas, cutting of individual plants is preferred to site mowing to minimize habitat disturbance. Cut stump treatments with Glyphosate or Triclopyr are effective in achieving die-back, however, follow-up treatments may be necessary because of the long-lived stores of seed in the soil. Biological control is not available for management of multiflora rose at this time, however, several options are being investigated.

NORWAY MAPLE *Acer platanoides*



Norway Maple Leaves

The Norway maple is a common tree throughout much of Europe, including Norway. An important commercial species in European timber markets, the Norway maple has similar uses in Europe as our sugar maple does here. Furniture and flooring are often made from the sawlogs, and the density of the wood makes it an excellent material for musical instrument soundboards.

Norway maples never grew in North America until they became recognized for two important landscaping attributes. The first is plasticity, for Norway maples have lent themselves to foliage color manipulations. The most popular variety has been the “Crimson King,” a Norway maple with very dark red (nearly black) foliage. The second desirable quality has been the species’ ability to withstand poor growing conditions, including infertile and compacted soils and atmospheric pollution. These two qualities

quickly promoted the Norway maple to become overplanted in New England and can be found in virtually every town in this region.

But plasticity and aggressiveness are not without ecological shortcomings, particularly when a plant is non-native. Norway maples have “escaped” cultivation as they successfully germinate from seed. Norway maples are better competitors for light and nutrients than many of our native species, particularly in disturbed areas. The fact that Norway maples outcompete native species puts increasing pressure on native species. The solution is to become more informed about the invasiveness of the species that are planted.



Norway Maple Seedlings

Management: Hand-pulling of saplings (use weed wrenches) or mowing seedlings may be the most efficient means for management of Norway maple. Mature trees will continue to produce seeds, so must be removed. Cutting and removing the mature trees may involve the services of an arborist or commercial forester. Treating the cut stumps with Garlon 4 (Triclopyr) or Roundup (Glyphosate) is necessary to prevent resprouting. Large trees that cannot be removed can be girdled with an axe (cut into the cambium) encircling the base of the tree 15 cm (6 in) above ground level. Glyphosate or Triclopyr can be squirted into the cut to kill the tree and reduce resprouting. When trees, saplings or seedlings are removed, replant the area with desired native trees or desirable undergrowth vegetation.

ORIENTAL BITTERSWEET *Celastrus orbiculatus* Thunb.



Oriental Bittersweet

Oriental bittersweet, an invasive exotic plant, is a deciduous, woody, perennial vine which sometimes occurs as a trailing shrub. Also known as round-leaved and Asiatic bittersweet, stems of older plants sometimes grow to four inches in diameter. Leaves of oriental bittersweet are glossy, rounded, finely toothed and arranged alternately along the stem. Clusters of small greenish flowers emerge from leaf axils, allowing each plant to produce large numbers of seeds. At maturity, globular, green to yellow fruits split open to reveal three red-orange, fleshy arils that contain the seeds. These showy fruits have made oriental bittersweet very popular for use in floral arrangements. Since this plant is easily confused with our native

climbing bittersweet vine (*Celastrus scandens*), which flowers at the tips rather than along the stems, it is imperative that correct identification be made before management is attempted.

Oriental bittersweet is an aggressive invader that threatens all vegetation levels of forested and open areas. It grows over other vegetation, completely covering it, and kills other plants by preventing photosynthesis, girdling, and uprooting by force of its massive weight. Oriental bittersweet appears to be displacing the native climbing bittersweet (*Celastrus scandens*), which occurs in similar habitats, through competition and hybridization. Oriental bittersweet occurs from New York to North Carolina, and westward to Illinois.

Oriental bittersweet infests forest edges, woodlands, early successional fields, hedgerows, coastal areas and salt marsh edges, particularly those suffering some form of land disturbance. While often found in more open, sunny sites, its tolerance for shade allows oriental bittersweet to invade forested areas. Oriental bittersweet reproduces prolifically by seed, which is readily dispersed to new areas by many species of birds. Its seeds germinate in late spring in partial to dense shade. It also expands vegetatively by stolons (above-ground stems), and rhizomes (underground stems), and through root suckering.

Management: Where hand labor is practical, vines can be pulled out by the roots and removed from the site, preferably before fruiting. If fruits are present, vines should be bagged and allowed to bake in the sun long enough to kill the seeds. Systemic herbicides, such as glyphosate (e.g., Roundup) or triclopyr (e.g., Garlon), that are taken into the roots and kill the entire plant, have been used successfully in bittersweet management. This method is most effective if the stems are first cut by hand or mowed and herbicide is applied immediately to cut stem tissue. In areas where spring wildflowers or other native plants occur, application of herbicides should be conducted prior to their emergence, delayed until after the last killing frost occurs, or carefully targeted. Herbicidal contact with desirable plants should always be avoided. No biological controls are currently known for oriental bittersweet.

A portion of this information was taken from a paper by Jil M. Swearingen, U.S. National Park Service, Washington, DC.

PURPLE LOOSESTRIFE *Lythrum salicaria* L.

Purple loosestrife was introduced to the northeastern U.S. and Canada in the 1800's for ornamental and medicinal uses. It enjoys an extended flowering season, generally from June to September, which allows it to produce vast quantities of seed. The flowers require pollination by insects, for which it supplies an abundant source of nectar. A mature plant will have as many as 30 flowering stems capable of producing an estimated two to three million seeds per year.

Purple loosestrife also reproduces vegetatively through underground stems at a rate of about 30.48 cm (1 ft) per year. Many new stems may emerge vegetatively from a single rootstock of the previous year. "Guaranteed sterile" cultivars of purple loosestrife are actually highly fertile and able to cross freely with other native species.



Purple Loosestrife

Purple loosestrife is an erect perennial herb with a square woody stem and opposite leaves. Plants are usually covered by downy fuzz. Plants grow from 1.22 – 3.05 m (4 – 10 ft) high, depending upon conditions, and produce a showy display of magenta flower spikes throughout much of the summer.

Purple loosestrife adapts readily to natural and disturbed wetlands. As it establishes and expands, it outcompetes and replaces native grasses, sedges and other flowering plants that provide a higher quality source of nutrition for wildlife. The highly invasive nature of this plant allows it to form dense stands that restrict native wetland plant species, including some federally endangered orchids, and reduce habitat for waterfowl.

Management: Small infestations can be pulled out by hand, preferably before seed set. For older plants, cut stump or spot treat with Glyphosate or Triclopyr. These herbicides may be most effective when applied late in the season when plants are preparing for dormancy. While herbicides and hand removal are useful, biological control is seen as the most likely for effective long-term control of large infestations. Three insect species have been approved by USDA for use as biological control agents. They are a root-mining weevil (*Hylobius transversovittatus*) and two leaf-feeding beetles (*Galerucella californiensis* and *Galerucella pusilla*). Several more insects are still under investigation.

WINGED BURNING BUSH *Euonymus alatus* (Thunb.)



Winged Burning Bush

Winged burning bush is a deciduous shrub from northeastern Asia to central China that will grow 4.57 – 6.1 m (15 – 20 ft) tall and equally as wide. The leaves turn bright red in the fall before dropping. Small green flowers bloom in May to early June.

This plant is also known as winged euonymus and was introduced into this country as an ornamental shrub. It is very adaptable to a variety of soils, performing best in well-drained soils. It grows well in full shade and full sun both. Burning bush is one of the most popular shrubs on the market; however, it may spread by seed from wherever it is used as an ornamental shrub.

The threat to natural areas from burning bush is that it shades out native herbs and crowds out native shrubs. Unfortunately, birds are fond of the red fruit and, therefore, distribute the seeds across the country where plants readily sprout and establish themselves. The shrub may become one of the most troublesome because of the ease with which its seeds are spread, the readiness of germination, its adaptability to various soils, its tolerance of full shade, and its spectacular fall foliage.

Management: Control is considered difficult once a plant has become established. It may not be much of a problem in cities, towns or developed areas. However, any woodlands where birds can roost may quickly become infested. Abstaining from using the plant will become the most important step toward control. Primary control at this point is pulling and digging out of plants. Herbicide applications and foliar spot-spraying in early summer may be necessary if large populations have become established.



Winged Burning Bush Fall Foliage

YELLOW FLAG IRIS *Iris pseudacoris* L.



Yellow Flag Iris

yellow flag iris is a fast growing and fast spreading weed. It creates thickets just like cattails, which can crowd out native vegetation.

Yellow flag iris was introduced into the United States from Europe and the Mediterranean region as an ornamental water plant. It is a perennial forb of shorelines and wetlands which reproduces by seeds and rhizomes. The iris can form very dense patches which will exclude other native plants.

The plant is 1.22 – 1.83 m (4 – 6 ft) tall and are usually spaced from about .91 – 1.22 m (3 – 4 ft) apart. It is the only yellow iris in the U.S. The roots are 10 – 30 cm (4 – 12 in) long. Iris leaves are flat, erect, stiff and sword shaped about 1.27 – 2.54 cm (1/2 – 1 in) wide. It has showy, yellow flowers with fruit capsules which resemble hanging bunches of short green bananas when mature. The iris produces resins which can cause human skin irritation and will sicken livestock if ingested.

The plant is slowly spread and easily contained. It is spread by wind and water. The wind catches the seed and blows it into the water, and the water carries it downstream. The

Management: There are no known biocontrol agents which are effective for this species. Pulling out and digging up of plants is effective if all plant material is removed. Avoid skin contact with resins. Glyphosate and Triclopyr are effective, particularly on regrowth following cutting. The use of a dripless wick applicator is recommended to avoid affecting other nontarget adjacent plants.

APPENDIX II

SAFETY

SAFETY

PESTICIDE SAFETY

Pesticides are insecticides, herbicides, fungicides, rodenticides and other chemicals used to control, prevent, destroy, repel or regulate pests. Pesticides have an EPA registration number on the label. This includes personal repellent products. As poisons, they can affect living organisms and usually may have adverse effects on other nontarget plants or animals, including humans. Because of their biological activity, pesticides can injure (or kill) adults, children, pets, livestock, wild animals, insects, birds, fish and plants. Pesticides must be carefully stored, handled and used to avoid exposure to nontargets.

Certification

Any person (park staff or contractor) who is involved in handling or applying pesticides should be trained in proper procedures. Protective equipment must be worn by the person handling, loading, mixing or applying any pesticide. Pesticides will only be applied by personnel who are properly trained and are supervised by a certified applicator or who are certified themselves. In New Hampshire, certified applicators must receive training, pass a test and attend periodic updating continuing education workshops or training to keep their certification current. The IPM Coordinator should be a state certified pesticide applicator.

Pesticide Information

Pesticide labels contain information on precautions for the safety of the pesticide applicator and cautions to be taken to protect or reduce exposure to other workers and/or visitors. The label is the law. Violating the label directions is a violation of FIFRA. Chemical (pesticide) labels on containers must not be removed or defaced. OSHA Hazard Communication Standard requires workers be trained and provided appropriate protective equipment and information (MSDS) on any hazardous material they might handle. Treated areas will be posted to provide the public (staff and visitors) with information on the pesticide used, the area treated, and the safe re-entry time (5 half lives). Keep an inventory of all pesticides used or stored in the park; copies of labels and MSDS should be stored with the products and also with the IPM Coordinator and the park safety officer.

Pesticide Storage

The pesticide storage facility should contain copies of labels, MSDS and inventory information. The pesticide storage structure must be properly posted with warning signs and securely locked. The structure must be fireproof and ventilated to the outside. Other materials such as cleaning fluids, paint, solvent, fuel oil, gasoline, kerosene or other chemicals should not be placed or stored in the pesticide storage structure because of the increased risk of fire or explosion. Different types of pesticides will be stored on separate shelves or compartments. The local Fire Department will be made aware of the storage location(s) and the types of pesticides stored so that a fire emergency plan is prepared.

Pesticide Disposal

The pesticide label has directions for procedures to follow to dispose of pesticide containers, pesticide and equipment rinsates. U.S. EPA and state regulations also address the disposal of hazardous substances. Limit the amount of material that needs to be disposed by:

- Purchasing only the amount needed for each treatment
- NPS policy limits the quantity of pesticide that can be purchased
- Mixing only the amount needed for the treatment
- Apply remaining mixed pesticide to the treated area according to label instructions
- Upon completion, triple rinse the spray equipment and apply the rinsate to the treated area (follow the label directions)
- Use single dose syringe applicator to apply gel baits
- Use containerized aerosol pesticides which can be reused until empty
- Use dust or granular pesticides that can be returned to the original container, if necessary, for storage

Excess unopened product can be considered to be “surplus property” and transferred to another agency in accordance with federal and state laws and regulations. Retain records of all donations of surplus pesticides.

Training

The IPM Coordinator should have attended the NPS IPM course, or be scheduled to take the course as soon as possible. Other key staff that have responsibilities related to pest management may also attend (forester, maintenance, natural resources, and supervisors). Pesticide applicators must take state certification classes and attend periodic updates. College or university courses on pesticide toxicology, wildlife management, botany, entomology and other life sciences can be useful.

The curator will complete the basic NPS curatorial training course and, if possible, the NPS 40-hour IPM training course. The curator may also maintain state pesticide applicator certification. Staff performing inspections or monitoring should receive at least eight hours of documented IPM training that includes methods of inspecting structures. Staff involved in rodent management should receive at least 16 hours of instruction including inspection and monitoring techniques, disease prevention, rodent management methods, sanitation, safety; tuning, setting and recovery of snap traps; rodenticide use processes and risks. Staff required to manage stinging insects (hornets, honey bees, yellowjackets) will receive at least four hours of training including protective equipment, insect and colony removal procedures, bystander management and emergency first aid. The IPM Coordinator will maintain copies of all staff IPM training documents.

Notification

Areas on the park (structures, grounds, forests, etc.) that are scheduled to be treated with any pesticide should be posted at least 24 hours prior to the treatment with warning information (target pest, pesticide to be used, signal word, date of treatment, area of treatment, re-entry date,

information phone number). The posted notice should be of a material that will not deteriorate in weather, and should be removed on the re-entry date. The local fire, police and EMS units should also be made aware of the treatment information. Members of the staff and local neighbors who are known to suffer from environmental illness (EI) or multiple chemical sensitivity (MCS) must also be notified at least 48 hours before the treatment so they can leave the area or protect themselves. Please refer to the Pesticide Treated Area Posting Form at the end of this section.

Spills

Pesticide spills need more detailed attention than spills of other materials. The spilled pesticide may also present a long-term hazard at the spill site and to responding or present personnel. If a pesticide spill has occurred, immediate procedures must be taken. The first action is to protect yourself: put on protective clothing, gloves, boots, tyvek coveralls, goggles and respirator. The second action is to isolate the area: do not allow unauthorized and unprotected personnel into the area. Identify the material and determine the hazard. If an unprotected person is involved or has succumbed, perform the rescue and administer first aid, then decontaminate the victim. Contain the spill. For liquids or dusts, dike off the area, stop any leaks, and use absorbent material to soak up the spill. A small spill (one pint or less, or one-half pound or less) may be contained with absorbent cloths, sand, bagged clay, or diatomaceous earth. A larger spill may necessitate soil dikes, sand snakes, commercial bagged clay or other containment efforts. For large spills, the Fire Department or other emergency responders may be called. For large spills of highly toxic pesticides, CHEMTREC can be called for containment and cleanup information. CHEMTREC may call the Pesticide Safety Team Network (PSTN) if a large quantity of pesticide is involved. Removing and decontaminating the material may require special procedures. Exposed staff or other personnel may need to be taken to hospitals for examination and treatment. Additional tests may be necessary over time, depending upon the pesticide exposure. The lesson is to not have toxic pesticides on site, and, if at all possible, avoid spills. Develop procedures for handling pesticides to avoid spills.

Spill kits can be developed and placed at storage, mixing and application sites. The kit should have diking or absorbent material sufficient to contain the amount of pesticide that may be involved (storage areas may need more than mixing areas), protective clothing and equipment, and emergency phone numbers. Absorbent material can be bagged clay, activated charcoal, diatomaceous earth or other highly absorbent material. There are also absorbent pads now available for absorbing pesticides.

HUMAN HEALTH

Disease Concerns

Most arthropod, bird and mammal pests come into direct contact with soil, dead and rotting organic material, and other sources of disease organisms which may provide opportunity for transmission to humans. This potential adverse effect of disease transmission to humans (park staff and visitors) is an important reason for an aggressive pest management program.

The advent of Hantavirus illness and death from exposure to rodent urine, feces and saliva poses a real concern for the presence of rodents in structures. Anyone involved in rodent management

actions should be aware of the risks of exposure to the deadly Hantavirus, which may be present in rodent urine, feces and saliva. Minimal protection may be necessary when inspecting for rodent activity, monitoring or setting traps (dust mask, surgical gloves). Trapped rodents can be removed by placing a zip loc bag inside-out over your hand, grabbing the trap and captured (dead) rodent with the zip loc bag, then turning the bag right-side out over the trap and dead rodent, zipping the bag closed and placing it into another sealable bag for disposal. If a person is involved in cleaning rodent-infested, enclosed areas (inside a structure) or removing rodent urine, fecal droppings, nesting or other rodent debris, that person must wear approved protective equipment and follow Department of Health or CDC guidelines. Minimum protective equipment includes rubber gloves, goggles, coveralls, and a respirator with a HEPA filter. Other rodent-borne diseases associated with rodents are bubonic plague (flea transmitted), murine typhus, rat bite fever, hemorrhagic fever, and several others.

Other sources of human disease can be transmitted by ectoparasites on rodents, other mammals, birds and insects feeding on dead animals or other organic material. Allergies, asthma and other serious health effects can manifest from contact with exuviae, pheromones and cockroach and other insect body parts and droppings.

Wildlife Concerns

Mice often nest in, under and around structures, and are particularly fond of the cavities (and warmth) in stoves and other kitchen appliances and cupboards. Their gnawing (to keep their teeth worn down) on wiring and other electrical appliances has been the cause of many fires. Some migratory birds are implicated in harboring and transmitting Avian flu through contact with the fecal droppings.

Insect stings by ants, bees, wasps and yellowjackets can also be a concern for human safety, especially those who are sensitized to the stings. Managing these pests where there may be contact by visitors or staff is important. In some cases, notices to wear repellants may be necessary to attempt to ward off mosquitoes, black flies, ticks or other biting pests.

WARNING

PESTICIDE TREATED AREA

An application of a pesticide was deemed necessary to manage pests that are invading this area.

This notice is: a 24-hour a 48-hour a 72-hour an Emergency posting

Product Name: _____ Mfg. Name: _____

Active Ingredient: _____ USEPA Reg. No.: _____

Target Pest(s): _____

Date of Application: _____

Date Sign May Be Removed: _____ (No less than 72 hours from application)

Signal Word: Danger Warning Caution

If you have questions regarding this notification or require additional information, please contact the Site IPM Coordinator at 603-675-2175, x 110.

APPENDIX III

SUPPLIES

SUPPLIES

Inspection Tools

- Flashlight
- Hand lens, 16x or better
- Probe for testing wood for rot
- Spatula for checking cracks and crevices
- Notebook and pen
- Digital camera
- Moisture meter
- UV light for detecting rodent urine stains



Inspection Tools

Exclusion Materials

- **¼ in. hardware cloth** (stainless steel or galvanized). Used for excluding rodents, birds and larger pests
- **Stuf-Fit** (copper mesh – won't rust). Used for closing small holes, cracks, crevices and around pipes penetrating walls and ceilings. Easy to stuff into openings to prevent access by insects, rodents and other small pests. Compresses easily.
- **Stainless steel wool or scrubbies** (won't rust). Used for filling larger holes to prevent pest access. May be difficult to compress.
- **Dap Brand Caulk**. Many different sealants and fillers to cover cracks, crevices, small holes or openings filled with Stuf-Fit or stainless steel wool, and varied surfaces.
- **Door sweeps**. Metal framed with rubber or neoprene blade to prevent insects and mice from entering a structure under the door. Wooden thresholds may be installed on the floor below the door to close the gap if it is historic. Brush-type door sweeps do not exclude mice, large beetles or cockroaches.

Monitoring Materials

- **Unscented talc**. Used for tracking patches to determine runways of rats, mice or insects inside structures (non-toxic).
- **Lo-Line Crawling Insect Sticky Traps**. Used for monitoring and capturing crawling insects inside structures. Best designed trap on the market at this time.
- **Insects Limited Flying Insect Pheromone Traps**. Many different traps for monitoring presence and capturing flying and other insects. Traps are usually specific to species or groups of species.

Snap Traps

- **Victor Brand** mouse and rat snap traps. The oldest and best snap trap available today. Use only those with the metal trigger (the plastic ones are slower). The metal trigger can be fine-tuned (hair-triggered) with a file and minor adjustments. Must be checked each morning.
- **Rat Zapper** by AgriZap, Inc. An electronic trap that electrocutes rats and mice that enter the tunnel for the bait. Must be checked each morning.

Low-Risk Pesticides (for use in structures, museum and garden areas)

- **Borid.** 99% Boric Acid powder which can be applied into cracks and crevices in structures to manage crawling insects.
- **Dekko Paks.** Borate based bait station designed for management of silverfish.
- **Drax Liquidator.** Boric Acid in sugar water bait for sweet-feeding ants. This slow-acting stomach poison is very effective for eliminating ant colonies. An excellent bait station for either inside or outdoor placement.
- **EcoEXEMPT IC.** An organic insecticide concentrate containing rosemary and other oils for use indoors and outdoors for crawling and flying insects.
- **Flea 'n Tick B Gone.** An enzyme treatment made from natural plant sources which has proven to effectively remove fleas, ticks, lice and other pests.
- **Hinder Deer & Rabbit Repellent.** Contains ammonium high fatty acid soaps to protect plants by forming a mild odor barrier. For use on vegetable, fruit and flower plants and shrubs.
- **Matran 2.** A FIFRA 25b exempt, non-selective, post-emergence herbicide which contains clove oil, water and lecithin. Can be used in and around all crop areas.
- **Nisus Corporation. BoraCare.** DOT insecticide with solvent to aid wood penetration for wood-destroying organisms (WDOs). Solution can be mixed with water and applied as a spray.
- **Nisus Corporation. Jecta.** DOT in a gel to be injected into posts or wood in contact with soil to prevent or treat for termites, mold, fungi and wood rot; can be used for a spot treatment.
- **Nisus Corporation. Niban FG Bait.** Boric Acid for the control of ants, cockroaches, crickets and silverfish. Can be used both inside and outside.
- **Nisus Corporation. Nibor-D.** A borate powder used as a dust, liquid or mop solution to kill and prevent infestations of carpenter ants, silverfish and mildew. For both interior and exterior use.
- **Nisus Corporation. TimBor Professional.** Disodium Octaborate Tetrahydrate [DOT] insecticide. For use on insects in cracks and crevices, and treating wood to prevent (or treat) termites, wood-destroying insects, mold and fungi. A powder material for crawling insects that can also be mixed with water and applied as a spray; will penetrate into (and through) the raw wood member.
- **Perma-Guard Commercial Insecticide.** Diatomaceous Earth mixed with Pyrethrin and Piperonyl Butoxide which can be dusted into cracks and crevices to manage crawling insects such as cockroaches, ants and silverfish.
- **Perma-Guard Fossil Shell Flour.** Pure Diatomaceous Earth powder which can be used to manage museum pests such as Indian Meal Moth, grain weevils, etc.
- **Perma-Guard Garden and Plant Insecticide.** Diatomaceous Earth mixed with Pyrethrin and Piperonyl Butoxide. This is an effective material for insect management on field crops, yards and gardens.
- **Tri Die.** Pressurized Silica and Pyrethrin dust for management of museum pests and crawling insects in structures.
- **Victor Wasp and Hornet Spray.** Contains Mint Oil and Sodium Lauryl Sulfate for the management of wasps, hornets and yellow jackets.

- **WOODguard.** A petroleum oil and solvent with Copper 8-Quinolinolate which can be sprayed or brushed on raw wood surfaces to prevent fungus, mold, wood rot and mildew. Provides water repellency.
- **WOW (Without Weeds).** Contains Maize Gluten Meal for pre-emergent weed management for lawns and gardens.

APPENDIX IV

GLOSSARY

GLOSSARY

ABSORPTION-The process by which a chemical or fluid is taken into the systems of human beings, plants, and animals.

ACARICIDE-A pesticide used to kill mites and ticks. A miticide is an acaricide.

ACTIVE INGREDIENT-The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. (Listed separately in the ingredient statement.)

ACUTE TOXICITY-The ability of a pesticide to cause injury within twenty-four hours following exposure. LD₅₀ and LC₅₀ are common indicators of the degree of acute toxicity. (See also Chronic Toxicity.)

ADJUVANT-A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION-The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high-organic soils tend to adsorb pesticides.

AEROSOL-A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALGAE-Simple aquatic plants that contain chlorophyll and are photosynthetic.

ALGICIDE-A pesticide used to kill or inhibit algae.

ANTI-SIPHONING DEVICE-A device attached to the filling hose that prevents backflow or backsiphoning from a spray tank into a water source.

ANTICOAGULANT-A chemical that prevents blood clotting. An active ingredient in some rodenticides.

ANTIDOTE-A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ARACHNID-A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are in the class Arachnida.

ARTHROPOD-An invertebrate animal characterized by jointed body and limbs. It is usually covered by a hard exoskeleton covering that is molted at intervals. For example, insects, mites, and crayfish are in the phylum Arthropoda.

ATTRACTANT-A substance or device that lures pests to a trap or poison bait.

AVICIDE-A pesticide used to repel or kill birds.

BACTERIA-Microscopic organisms, some of which are capable of producing diseases in people, plants and animals. Some bacteria are beneficial.

BACTERICIDE-Chemical used to kill bacteria.

BAIT-A food or other substance used to attract a pest to a pesticide or a trap.

BAND APPLICATION-Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BARRIER APPLICATION-See band application.

BENEFICIAL INSECT-An insect that is useful or helpful to people, such as insect parasites, predators, or pollinators.

BIOLOGICAL CONTROL-Management of pests using beneficial arthropods as predators, parasites, and disease-causing organisms which may occur naturally or are introduced to reduce pest populations.

BIOMAGNIFICATION-The process by which one organism accumulates chemical residues in higher concentration from other organisms which they have consumed.

BOTANICAL PESTICIDE-A pesticide produced from chemicals found in plants. Examples are nicotine, pyrethrins, and strychnine.

BRAND NAME-The name, or designation of a specific pesticide product or device made by a manufacturer or formulator. (A marketing name.)

CALIBRATE, CALIBRATION OF EQUIPMENT OR APPLICATION METHOD-Measurement and adjustment to control the output or rate of dispensing pesticides.

CARBAMATES-(N-Methyl Carbamates). A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-Methyl Carbamates are insecticides and inhibit cholinesterase in animals.

CARCINOGENIC-The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER-An inert liquid, solid, or gas added to an active ingredient for delivering a pesticide to the target effectively. A carrier is usually water, oil, or other solvent, used to dilute the formulated product for application.

CARRYING CAPACITY-The number of organisms for which a specific site can provide life support.

CERTIFIED APPLICATORS-Individuals who are certified by the state to use or supervise the use of restricted-use pesticides.

CHEMICAL NAME-The scientific name of active ingredients found in formulated products. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL-Pesticide application to kill pests.

CHEMOSTERILANT-A chemical compound capable of preventing animal reproduction.

CHEMTREC-The Chemical Transportation Emergency Center which has a toll-free number (800-424-9300) for providing 24-hour information only for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON-A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment, such as Chlordane and DDT. Only a few are registered for use in the U.S.

CHOLINESTERASE, ACETYLCHOLINESTERASE-An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-Methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY-The ability of a pesticide chemical to cause injury or illness (beyond 24 hours following exposure) when applied in small amounts repeatedly for a longer period of time. Chronic effects can also result from a single exposure. (See also Acute Toxicity.)

COMMERCIAL APPLICATOR-A state-certified applicator who for compensation uses or supervises the use of pesticides classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME-A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but the active ingredient has only one recognized common name.

COMMUNITY-The different populations of animal or plant species that exist together in an ecosystem (See also Population and Ecosystem.)

COMPETENT-Individuals properly qualified to perform functions associated with pesticide application. The degree of competency (capability) required is directly related to the nature of the activity and the associated responsibility.

CONCENTRATION-Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTACT PESTICIDE-A pesticide that causes death or injury to pests when in contact with it. The chemical does not have to be ingested. It is often used to describe a spray applied directly on a pest.

CONTAMINATION-The presence of an unwanted substance (sometimes pesticides) in or on a plant, animal, soil, water, air, or structure.

CULTURAL CONTROL-A pest management method that includes changing human habits, such as sanitation, changing work practices, or cleaning or garbage pick-up schedules.

DECONTAMINATE-To remove or break down a pesticidal chemical from a surface or substance.

DEGRADATION-A process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT-The amount of pesticide on a treated surface after application.

DERMAL TOXICITY-The ability of a pesticide to cause acute illness or injury to human beings or animals when absorbed through the skin (see Exposure Route.)

DESICCANT-A type of pesticide that draws moisture or fluid from a plant or arthropod pest, causing it to die. Certain desiccant dusts destroy the waxy outer coating that holds moisture within an insect's body.

DETOXIFY-To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS-The positive identification of a problem and its cause.

DILUENT-Any liquid, gas or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT-A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE-Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT-The airborne movement of a pesticide spray or dust beyond the intended target area.

DUST-A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM-The pest-management unit. It includes a community (of populations) with the necessary physical (harborage, moisture, temperature), and biotic (food, hosts) supporting factors that allow a population of pests to persist.

EMULSIFIABLE CONCENTRATE (EC)-A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER)-A chemical that aids the suspension of a liquid in another that normally would not mix together.

EMULSION-A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION-A pesticide formulation with its active ingredient enclosed in tiny capsules of polyvinyl or other materials; principally used for slow release. The enclosed active ingredient moves out to the capsule surface as pesticide on the surface is removed (volatilizes, or rubs off).

ENDANGERED SPECIES-Individual plants or animals with a population that has been reduced to the extent that it is near extinction and that has been designated to be endangered by a federal agency.

ENTRY INTERVAL-See Re-entry Interval.

ENVIRONMENT-Air, land, water, plants, people, animals, and the interrelationships which exist among them.

EPA - ENVIRONMENTAL PROTECTION AGENCY-The federal agency responsible for ensuring the protection of people and the environment from potentially adverse effects of pesticides and other contaminants.

EPA ESTABLISHMENT NUMBER-A number assigned to each pesticide-production plant by the EPA. The number indicating the plant at which the pesticide product was produced must appear on all labels of that product.

EPA REGISTRATION NUMBER-An identification number assigned to a pesticide product when it is registered by the EPA for use. The number must appear on all labels of pesticide products.

ERADICATION-The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE-The manner - dermal (through the skin), oral (through the mouth), or inhalation/respiratory - in which a pesticide may enter an organism.

FIFRA-The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that controls pesticide registration and use.

FLOWABLE-A pesticide formulation in which very finely ground solid particles are suspended (not dissolved) in a liquid carrier.

FOG TREATMENT-A pesticide in aerosol-sized droplets (under 40 microns). Not a mist or gas. After propulsion, the fog droplets fall on exposed surfaces.

FORMULATION-The pesticide product as purchased, containing a mixture of one or more active ingredients, and carriers (inert ingredients), with other additives making it easy to store, dilute, and apply.

FUMIGANT-A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state, penetrating voids to kill pests.

FUNGICIDE-A chemical used to kill fungi.

FUNGUS (plural - fungi)-A group of small, often microscopic, organisms in the plant kingdom which cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19%). Fungi are extremely important in the diet of many insects.

GENERAL USE (UNCLASSIFIED) PESTICIDE-A pesticide which can be purchased and used by the general public. (See also Restricted Use Pesticide.)

GRANULE-A dry pesticide formulation. An active ingredient is either mixed with or applied as a coating to an inert carrier to form a small, ready-to-use, low-concentrate chemical which normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER-Water source located beneath the soil surface from which springs and well water are drawn (see also Surface Water.)

HABITAT MODIFICATION-Removing food, water, shelter, and other conditions that support pests, or excluding access by pests to the site.

HALF LIFE-The time required for half of something (i.e. pesticide) to undergo a specific process (chemical degradation), so that only one-half of the applied material is still active (i.e. half life of Chlordane in soil is about 75 years).

HANTAVIRUS-A deadly virus transmitted to humans through contact with rodent feces, urine and saliva resulting in acute respiratory failure.

HARBORAGE-Shelter that provides the basic needs, including a safe place for the pest population.

HAZARD-See Risk.

HERBICIDE-A pesticide used to kill or inhibit plant growth.

HIGH-RISK PERSON-A person who has some condition that may put him or her at risk from exposure to pesticides. Such persons include children, the elderly, pregnant women, newborns, asthmatics, the neurologically impaired, the environmentally ill (EI), and those with multiple chemical sensitivity (MCS).

HOST-Any animal or plant on or in which another lives for nourishment, development, or protection.

IGR, INSECT GROWTH REGULATOR JUVENOID-A pesticide which mimics insect hormones that control molting and the development of insect systems affecting the change from immature to adult (see Juvenile Hormone.)

INERT INGREDIENT-An inactive material without pesticidal activity in a pesticide formulation, but which may be hazardous for some other reason; i.e., petroleum derivatives.

INGREDIENT STATEMENT-A portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION-Taking a substance in through the lungs (breathing in). (See Exposure Route.)

INSECT GROWTH REGULATOR-See IGR.

INSECTICIDE-A pesticide used to manage or prevent damage caused by insects.

INSECTS, INSECTA-A class in the phylum Arthropoda characterized by a body composed of three segments and three pair of legs.

INSPECTION-A process for detecting pests, pest damage, and evidence of pest activity in a managed site. (See Monitoring.)

INTEGRATED PEST MANAGEMENT-See IPM.

IPM-Integrated pest management. The coordinated use of pest and environmental information with available pest management methods to prevent unacceptable levels of pest damage by the most economical means, and with the least possible hazard to people and the environment. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary management method, but is an element of IPM, as are cultural and structural alterations. IPM programs stress communication, monitoring, inspection, and evaluation (keeping and using records).

JUVENILE HORMONE-A hormone produced by an insect that inhibits change or molting. As long as juvenile hormone is present the insect does not develop into an adult, but remains immature.

LABEL-All printed material attached to or on a pesticide container.

LABELING-The pesticide product label and other accompanying materials that contain directions for use that pesticide users are legally required to follow.

LARVA (plural - larvae)-The developmental stage of insects with complete metamorphosis that hatches from the egg. A mature larva becomes a pupa.

LC₅₀-Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC₅₀ is usually expressed in parts per million (ppm). The lower the LC₅₀ value, the more acutely toxic the chemical.

LD₅₀-Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test population of animals when eaten or absorbed through the skin. LD₅₀ is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD₅₀, the more acutely toxic the pesticide.

LEACHING-The movement of a substance with water downward through soil.

LYME DISEASE-A debilitating disease mainly affecting joints that is transmitted to humans through the bite of ticks, especially the Deer Tick.

METAMORPHOSIS-A change in the shape or form of an animal. Usually used when referring to insect development.

MICROBIAL DEGRADATION-Breakdown of a chemical by microorganisms.

MICROBIAL PESTICIDE-Bacteria, viruses, fungi, and other microorganisms used to manage pests. Also called biorationals.

MICROORGANISM-An organism so small that it can be seen only with the aid of a microscope.

MITICIDE-A pesticide used to kill mites (see Acaricide.)

MODE OF ACTION-The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOLLUSCICIDE-A chemical used to kill snails and slugs.

MONITORING-Ongoing surveillance. Monitoring includes periodic inspection and record-keeping. Monitoring records allow technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the pest-management program.

MSDS-Material Safety Data Sheet required by Department of Labor to be provided by manufacturers to those who request information on chemical substances. Included is data on flammability, eye hazards, protective equipment necessary, spill/clean-up instructions, and other hazard information.

NECROSIS-Death of plant or animal tissues which results in the formation of discolored, sunken, or necrotic (dead) areas.

NONTARGET ORGANISM-Any plant or animal other than the intended targets of pesticide application.

NYMPH-The developmental stage of insects with gradual metamorphosis that hatches from the egg. Nymphs become adults.

ORAL TOXICITY-The effect of a pesticide resulting in injury or acute illness when taken by mouth.

ORGANOPHOSPHATES-A large group of pesticides that contain phosphorus and inhibit cholinesterase in animals; i.e., Malathion and Diazinon.

PARASITE-A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PATHOGEN-A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT-Devices and clothing intended to protect a person from exposure to pesticides, including items like long-sleeved shirts, long trousers, coveralls, hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT-See IPM.

PEST-An undesirable organism including any insect, rodent, nematode, fungus, weed, or some terrestrial and aquatic plants and animals, virus, bacteria, or micro-organism which the US EPA Administrator declares to be a pest under FIFRA, Section 25(c)(1).

PESTICIDE-A chemical or other agent used to kill, repel, or otherwise manage pests or to protect from a pest.

pH-A measure of acidity/alkalinity of a liquid: acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE-A substance emitted by an animal to influence the behavior of other animals of the same species. Some are synthetically produced for use in insect traps.

PHOTODEGRADATION-Breakdown of chemicals by the action of light.

PHYSICAL CONTROL-Habitat alteration or changing the infested physical structure, such as by caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, and other means.

PHYSIOLOGICAL SENSITIVITIES-Human physiological reaction from exposure in the environment to perhaps minute amounts of chemicals that produce an adverse response.

PHYTOTOXICITY-Injury to plants caused by a chemical or other agent.

POINT OF RUNOFF-The point at which a spray starts to run or drip from the surface to which it is applied.

POISON CONTROL CENTER-A local agency, generally a hospital, which has current information on the proper first-aid techniques and antidotes for poisoning emergencies. Such centers are listed in telephone directories.

POPULATION-Individuals of the same species. The populations in an area make up a community (see Ecosystem.)

PORT-Small sealable hole that allows injection of pesticidal material into a wall or other void in a structure.

PRECIPITATE-A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR-An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, spiders, lady-bird beetles and other insects.

PROFESSIONAL-One who is trained to conduct an efficient operation and able to make judgments based on training and experience.

PROPELLANT-The inert ingredient in pressurized containers that forces an active ingredient from the container.

PUPA (plural - pupae)-The developmental stage of insects with complete metamorphosis when major changes from larval to adult form occurs.

QUALIFIED APPLICATOR-An applicator who is certified (and licensed in some states) to apply restricted-use pesticides in the state. Qualification may also include training or experience.

RATE OF APPLICATION-The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured per acre, per 1,000 square feet, per linear foot, or per cubic foot.

RE-ENTRY INTERVAL-The length of time following an application of a pesticide during which entry into the treated area is restricted. Also known as Entry Interval.

REGISTERED PESTICIDES-Pesticide products which have been registered by the Environmental Protection Agency for uses listed on the label.

REPELLENT-A compound that keeps insects, rodents, birds, or other pests away from plants, domestic animals, buildings, or other treated areas.

RESIDUAL PESTICIDE-A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE-The pesticide active ingredient or its breakdown products which remain in or on the target after treatment.

RESTRICTED USE PESTICIDE-A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RISK-A probability that a given pesticide will have an adverse effect on people or the environment in a given situation.

RMSF-Rocky Mountain Spotted Fever is an acute infectious rickettsial disease transmitted to humans by the American dog tick.

RODENTICIDE-A pesticide used to kill rodents.

RUNOFF-The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SANITATION-The practice of removing undesirable substances that support a pest or pest population (for instance, food or water).

SIGNAL WORDS-Required wording which appears on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, or CAUTION.

SITE-Areas of actual pest infestation. Each site should be treated specifically or individually.

SOIL INJECTION-The placement of a pesticide below the surface of the soil, a common application method for termiticides.

SOIL DRENCH-To soak or wet the ground surface with pesticide. Large volumes of pesticides are usually needed to saturate the soil to a sufficient depth.

SOIL INCORPORATION-The mechanical mixing of a pesticide product with soil.

SOLUTION-A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are dissolved. Example: sugar in water.

SOLVENT-A liquid which will dissolve another substance (solid, liquid, or gas) to form a solution.

SPACE SPRAY-A pesticide which is applied as a fine spray or mist to a confined area.

STOMACH POISON-A pesticide that must be eaten by an animal in order to be effective; it will not kill on contact.

SURFACE WATER-Water on the earth's surface such as rivers, lakes, ponds, and streams. (See Groundwater.)

SUSPENSION-A pesticide mixture consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

TARGET-Plants, animals, structures, areas, or pests toward which the pesticide or other management method is directed.

TECHNICAL MATERIAL-Pesticide active ingredient in pure form, as it is manufactured by a chemical company. It is combined with inert ingredients or additives in formulations such as wettable powders, dusts, emulsifiable concentrates, or granules.

TOXIC-Poisonous to living organisms.

THRESHOLD-A level of pest density. The number of pests observed, trapped, or counted that can be tolerated without an economic loss or aesthetic injury. Thresholds in pest management may be site specific. For example, different numbers of flies may be tolerated at different sites (canoe warehouse and kitchen would have different thresholds).

TOLERABLE LEVELS OF PESTS-The presence of pests, at certain levels, is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, or unacceptable cost. The tolerable level in some situations will be near zero. Urban pest management programs may have lower tolerable levels of pests than rural programs.

TOXICANT-A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY-The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. (The degree or extent that a chemical or substance is poisonous.)

TOXIN-A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

UNCLASSIFIED PESTICIDE-See General-Use Pesticide.

USE-The performance of pesticide-related activities requiring certification including application, mixing, loading, transport, storage, or handling after the manufacturing seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their

containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR PRESSURE-The property which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the more easily it will evaporate.

VECTOR-A carrier, an animal (such as an insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE-Animal characterized by a segmented backbone or spinal column.

VIRUS-Ultramicroscopic parasites composed of proteins. Viruses can only multiply in living tissues, and they cause many animal and plant diseases.

VOID-Space inside walls or other inaccessible space that may harbor pests.

VOLATILITY-The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE-The upper level of the water-saturated zone in the ground.

WEST NILE VIRUS-A disease transmitted to humans and other animals by the bite of a mosquito. Birds (notably Corvids) act as a reservoir and may die as a result.

WETTABLE POWDER-A dry pesticide formulation in powder form that forms a suspension when added to water.

ZONE-The management unit, an area of potential pest infestation made up of infested sites. Zones will contain pest food, water, and harborage. A kitchen-bathroom arrangement in motel units might make up a zone; the canoe warehouse may make up another. Zones may also be established by eliminating areas with little likelihood of infestation and treating the remainder as a zone. A zone will be an ecosystem.

APPENDIX V

IPM INSPECTION FORMS

STRUCTURAL IPM INSPECTION FORM

Date_____

Inspector_____

Assisted by_____

Code Numbers for Problems on Form/Map:

1 = Roaches

2 = Flying Insects (flies, moths)

3 = Other Insects

4 = Rodent Sign

5 = Housekeeping

6 = Maintenance

7 = Bird Sign

8 = Squirrels

9 = WDOs

10 = Other

Abbreviations: PTW = Pressure Treated Wood

FWJ = Floor Wall Junction

1. OUTSIDE - Curtilage:

Pests known present.....

Garbage/dumpster conditions.....

General area cleanliness.....

Dead trees/sod debris/termites.....

Pest harborage/debris on ground.....

Pest breeding (water, food, shelter).....

Paving/walk drainage problems.....

Wood too close to structure.....

Plants too close to building.....

General wood control.....

Hazardous trees/limbs.....

Shed/outbuilding problems.....

Rodent burrows/sign/holes.....

Pet/bird feeders/waterers.....

Insect evidence/harborage garden?.....

Vertebrate evidence/holes.....

2. FOUNDATION - Exterior

Pests known present.....

A. Foundation:

Building corners square foundations.....

Foundation intact: dirt/wood contact?.....

Wood-concrete-soil contacts/PTW.....

Foundation cracks.....

36 in. clear area around structure (1 in. gravel).....

B. Grade

Soil drainage characteristics.....

Grade from structure (6 in/10 ft.).....

Grade and water accumulations.....

C. Siding/Building Exterior

Downspout drains splash on siding?.....

Splash blocks perforated pipe.....

Main siding peeling paint/buckling?.....

Water/air conditioner leaks.....

Rusty nails/wood streaking.....

Discolored/decayed wood siding.....

Wood pick test results.....

Wood moisture readings.....

Wood junctions caulked.....

Porch and soffit conditions.....

Tongue & groove flooring caulked.....

Door sweeps/good door closure.....

Metal kickplates on doors.....

Window frame conditions.....

Vents/exhaust/conduits screened.....

Cracks/holes around pipes/wires.....

Outside lights away from doors/on poles; high pressure sodium bulbs; covers clean.....

Trees touching/overhanging structure.....

Plants/plantings/planters/trellises.....

Trash/debris accumulations.....

Insect/vertebrate evidence/harborage.....

D. Food Establishments

Loading docks/receiving areas clean.....

Garbage area removed from structure.....

Other outside storage/spills.....

Exterior wall/foundation cracks.....

E. Structural Roof

Pests known present.....

Missing shingles/cracks in surface.....

Moss/lichen/algae/fungus on roof.....

Rusty iron nails in roofing.....

Shingles/roof intact.....

Shingle extension 1 ft. eave (12-24-30).....

Gutters clean, not clogged.....

Chimney/vents screened.....

Bird problems in eaves.....

Chimney flashing/construction tight.....

Dormer flashing/construction tight.....

Soffit flashing tight.....

Wires from roof pest-protected.....

Insect evidence/harborage.....

Fascia tight/painted (carpenter bees).....

3. INSIDE - Crawlspace

Pests known present.....

Monitor (repair) structure twice a year (spring/fall) for moisture/damage.....

Vents screened/open/in wells.....

Height of crawlspace (18 in. t joists).....

Wood/soil contact.....

Wood pick test results.....

Termite shields installed.....

Leaking pipes.....

Structural wood type.....

Wet areas? Why? Moisture readings.....

Mold/fungus/decay/insect damage.....

Wood debris present.....

Evident floor/wood shrinkage.....

Vapor barrier? Intact?.....

Pest access into structure thru floor.....

Active insect infestations?.....

Vertebrate sign?.....

Ventilation: 1 sf/150 sf; within 3 ft. of corner.....

Crawlspace access door clear.....

4. INSIDE - Structural

Pests known present.....

A. Basement

Walls dry/moisture readings.....

Storage condition/sanitation.....

Wood moisture in sill area.....

Floor drains clean/screened.....

Sticky trap monitoring.....

Trash collection practices.....

Insect evidence/harborage.....

Reception desk area.....

Exhibit area: general pest risks?.....

Exterior door conditions.....

Offices: neatness/problem areas.....

Eating/storing food at desks.....

Computers/elec equipment problems.....

Insect attracting items in building?.....

Insect evidence/harborage.....

Lunchroom/coffeemaking area.....

Vending machines.....

Trash collection practices.....

Decorate plants.....

General Sanitation/lint.....

Cracks/holes in floor.....

Suspended ceilings/light fixtures.....

Custodial storage area.....
Wet mops/rags/sour drains.....
Electrical boxes/equipment.....
Drains cleaned/screened.....

Countertops caulked/intact.....

Exhaust vents.....

Water leaks/pipe sweating/hot water heater.....

Drains clear/good condition.....

Food stored in cans/glass.....

Shelves clean/no shelf paper.....

Refrigerator pan/motor.....

Windows tight/insect presence.....

Condition of walls/grease/moisture.....

Storage 6 in. off floor.....

Dishwasher cleanliness/pests.....

Stove vent clean/screened.....

Stove/refrigerator doors clean.....

Hollow legs on tables/chairs/rails?.....

Equipment elevated on legs.....

Conditions under lowest drawers.....

Trash covered; out every night.....

Dishes kept in water until cleaned.....

Outside trash covered; cans cleaned weekly.....

Insect evidence/harborage.....

Dry storage areas.....

Areas behind false fronts on equipment.....

Loose floor tile/screened drains.....

Regularly emptied trash containers.....

Area around can opener/grease hoods.....

Condition of window frames.....

Employee lockers.....

Air doors/vanes positioned correctly.....

Door sweeps.....

Water leaks at tub/shower/toilet; fungus.....
 Floor strength near toilet.....
 Water leaks under sink.....
 Condition of window frames.....
 Blistered ceiling/wall paint.....
 Insect evidence/harborage.....

Sufficient ventilation.....
Insect/pest evidence/harborage.....
Vents screened.....
Temperature.....
Roof/wall junction tight seal.....
Rodent evidence.....
Exposed/chewed wiring.....
Appliance venting.....
Frozen condensation/ice dams.....
Bat presence.....

Floors:

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9 Hard hat	9 Overalls and/or bee suit
9 Insect repellent	9 Bee veil
9 Knee pads	9 Smoker and fuel
9 Gloves, heavy/medical	9 Wasp Freeze
9 Face shield/goggles	9 Fly swatter
9 Dust mask/respirator	9

9 Clipboard/grid/paper	9 Masking/filament tape
9 Inspection forms	9 Portable vacuum cleaner
9 Pencil/pen	9 Ladders/rope/carabiner
9 Insect keys/info	9 Sharp probe (wood awl)
9 Aspirator/collecting vials	9 White coveralls
9 Flashlight/headlamp	9 Belt pouch for tools
9 Flashlight batteries	9 Extendable mirror
9 Hand duster	9 Tape measure/6 in ruler
9 Vials w/alcohol	9 Plastic zip locs
9 Polaroid/digital camera	9 Slide camera
9 Belt/leatherman/knife	9 Colored sticky labels
9 15x Hand lens/loupe	9 Binoculars
9 Film/flash	9 Moisture meter/thermometer
9 Caulk	9 Small hand trowel
9 Lo-line sticky traps	9 Knee/elbow pads
9 Screwdriver/phillips/slot	9 Spatula
9 Crescent/general wrench	9 Rechargeable drill
9 Forceps	9 Stethoscope
9 Pocket tape recorder	9 Optivisor
9 Pliers	9 Hand mirror
9	9
9	9

COMMENTS.....

LANDSCAPE IPM INSPECTION FORM

Site_____

Date_____

Inspector_____

Assisted by_____

PESTS PRESENT

VERTEBRATES	LOCATION	ACTION
INSECTS	LOCATION	ACTION
WEEDS	LOCATION	ACTION

INSECT PHEROMONE MONITORING TRAPS

SPECIES	COUNTS	LOCATION

OTHER OBSERVATIONS – i.e., Plants too Close to Structures, etc.

APPENDIX VI

PEST SIGHTING LOG

Saint-Gaudens National Historic Site

Have you seen any pests lately? Please jot down your observations!



Pest Activity Log: _____

Report of Pest Sighting			
Date	Name/Phone	Location/Building	Pest/Problem Description

PLEASE RETAIN ORIGINAL FOR COPYING.



APPENDIX VII

BIBLIOGRAPHY

BIBLIOGRAPHY

- Apple, J. L. and R. F. Smith. 1976. Integrated Pest Management. Plenum Press, New York, New York 10011.
- Bello, P. J. 1997. Occasional Invaders. In: Mallis, A. Handbook of Pest Control, 8th Edition; Mallis Handbook & Technical Training Company.
- Bennett, G. W., J. M. Owens, R. M. Corrigan. 1988. Truman's Scientific Guide to Pest Control Operations; Purdue University, Edgell Communications.
- Briggs, S. A. 1992. Basic Guide to Pesticides: Their Characteristics and Hazards. Hemisphere Publishing Corporation, Taylor & Francis, Washington, D. C. 20005.
- Christensen, Dr. C. A. 1983. A Technician's Handbook to the Identification and Control of Insect Pests. Pest Control Technology, Cleveland, Ohio.
- Craft, J. A. 1990. Crickets. In: Mallis, A. Handbook of Pest Control, 7th Edition; Franzak & Foster Co., Cleveland Ohio.
- Currie, W. E. 2002. Pest Management Plan for Scotty's Castle, Death Valley National Park. International Pest Management Institute, Ash Fork, Arizona 86320.
- Currie, W. E. 2005. Pest Management Plan for the Jefferson National Expansion Memorial. International Pest Management Institute, Ash Fork, Arizona 86320.
- Currie, W. E. 2006. Pest Management Plan for Grand Portage National Monument. International Pest Management Institute, Ash Fork, Arizona 86320.
- Currie, W. E. 2006. Pest Management Plan for Morristown National Historical Park. International Pest Management Institute, Ash Fork, Arizona 86320.
- Currie, W. E. and L. S. Hawkins. 1995. Manual of Integrated Pest Management for Schools, Parks and Other Public Sites. International Pest Management Institute, Ash Fork, Arizona 86320.
- Ebling, W. 1978. Urban Entomology. Division of Agricultural Sciences, University of California.
- Ellis, B. W. and F. M. Bradley. 1992. The Organic Gardener's Handbook of Natural Insect and Disease Control. Rodale Press, Emmaus, Pennsylvania 18098.
- Flint, M. L. and P. Gouveia. 2001. IPM in Practice: Principles and Methods of Integrated Pest Management. Publication #3418. University of California, Oakland, California 94608.
- Forbes, C.F. and W. Ebeling. 1987. Use of Heat for Eliminating Structural Pests. IPM Practitioner 9(8):1-5.
- Gilkeson, L., P. Peirce and M. Smith. 1996. Pest and Disease Problem Solver: A Chemical-Free Guide to Keeping Your Garden Healthy. Rodale Press, Emmaus, Pennsylvania 18098.

- Glass, G. E., J. S. Johnson, G. A. Hoddenbach, C. L. J. DiSalvo, C. J. Peters, J. E. Childs, and J. N. Mills. 1997. Experimental Evaluation of Rodent Exclusion Methods to Reduce Hantavirus Transmission to Humans in Rural Housing. *Amer. Jour. Tropical Med. and Hygiene*.
- Gorham, J. R. 1991. Ecology and Management of Food-Industry Pests. Association of Official Analytical Chemists, Arlington, Virginia 22201
- Haack, K. D. and T. A. Granovsky, 1990. Ants. In Handbook of Pest Control; Franzak & Foster, Cleveland Ohio.
- Hadidian, J., G. R. Hodge and J. W. Grandy. 1997. Wild Neighbors: The Humane Approach to Living with Wildlife. The Humane Society of the United States. Fulcrum Publishing, Golden, Colorado 80403.
- Hallman, G. J. and D. L. Denlinger. 1998. Temperature Sensitivity in Insects and Application in Integrated Pest Management; Westview Press, Boulder, Colorado 80301.
- Harmon, J. D. 1993. Integrated Pest Management in Museum, Library, and Archival Facilities. Harmon Preservation Pest Management Publications, Indianapolis, Indiana 46240.
- Hedges, S. A. 1991. Managing Pests Without Pesticides. *Pest Control Technology*, Jan. 1991.
- Hedges, S. A. 1993. Field Guide for the Management of Structure Infesting Ants; Franzak & Foster Co., Cleveland Ohio.
- Hedges, S. A. 1994. Field Guide for the Management of Structure Infesting Flies; Franzak & Foster Co., Cleveland Ohio.
- Hedges, S. A. and M. S. Lacey. 1995. Field Guide for the Management of Urban Spiders; Franzak & Foster Co., Cleveland Ohio.
- Hedges, S. A. 1997. Ants. In: Mallis, A. Handbook of Pest Control, 8th Edition; Mallis Handbook & Technical Training Company.
- Hoddenbach, G. A., J. Johnson, and C. DiSalvo. 1997. NPS Rodent Exclusion Manual (Mechanical Rodent-Proofing Techniques), National Park Service, Public Health Program, Washington, D.C.
- Jackson, W. B. 1990. Rats and Mice. In: Mallis, Arnold. 1990. Handbook of Pest Control. Franzak & Foster Co., Cleveland, Ohio.
- Johnson, W. T. and H. H. Lyon. 1991. Insects that Feed on Trees and Shrubs. Cornell University Press, Ithaca, New York 14850.
- Leslie, A. R. 1994. Handbook of Integrated Pest Management for Turf and Ornamentals. U.S. Environmental Protection Agency, Washington, D.C.
- Levy, M. P. 1975. A Guide to the Inspection of Existing Homes for Wood-Inhabiting Fungi and Insects. U.S. Department Housing and Urban Development, Washington, D.C.
- Mallis, A., Handbook of Pest Control. 1982 and 1990. Franzak and Foster.

- Marer, P. J. 1991. Residential, Industrial and Institutional Pest Control. University of California, Oakland, California 94608.
- Marsh, R. E., T. P. Salmon, and W. E. Howard. 1981. Integrated Management of Rodents and Other Wildlife in Campgrounds. U.S. Department of Agriculture, U.S. Forest Service.
- Meehan, A. P. 1984. Rats and Mice: Their Biology and Control. The Rentokil Limited, Sussex, England.
- Moore, H. B. 1979. Wood-Infesting Insects in Houses: Their Identification, Biology, Prevention and Control. U.S. Department of Agriculture, U.S. Forest Services and the Department of Housing and Urban Development.
- National Academy of Sciences. Pest Control and Public Health, Volume V. 1976. Printing and Publishing Office, Washington, D.C. 20418.
- National Park Service. Hantavirus Infection Interim Recommendations for Risk Reduction. 1993.
- National Park Service. IPM Information Manuals. 1985 and 1993 editions.
- Neuweiler, G. 2000. The Biology of Bats. Translated by E. Covey. Oxford University Press. New York, New York 10016.
- Norment, B. R. 1990. Spiders. In Mallis, A. 1990. Handbook of Pest Control, 7th Edition; Franzak & Foster Co., Cleveland Ohio.
- Olkowski, W.; S. Daar, H. Olkowski. 1991. Common Sense Pest Control; Chapter 13, Pests of Fabric, Feathers, and Paper. Bio-Integral Resource Center, Berkeley, California.
- Pedigo, L. P. 1996. Entomology and Pest Management, Third Edition. Prentice-Hall, Inc., Upper Saddle River, New Jersey 07458.
- Pinto, L. 1990. Occasional Invaders. In: Arnold Mallis, Handbook of Pest Control, 7th Edition; Franzak & Foster Co., Cleveland Ohio.
- Potter, D. A. 1998. Destructive Turfgrass Insects: Biology, Diagnosis and Control. Ann Arbor Press, Inc., Chelsea, Michigan 48118.
- Prakash, I., Ph.D., D.Sc. 1988. Rodent Pest Management. C. R. Press, Boca Raton, Florida 33431.
- Pratt, H. D. 1975. Sanitation in the Control of Insects and Rodents of Public Health Importance. U.S. Dept. Health, Education, & Welfare; U.S. Public Health Service, Centers for Disease Control, Atlanta Georgia.
- Pratt, H. D. and R. Z. Brown. 1976. Biological Factors in Domestic Rodent Control. U.S. Department of Health, Education, and Welfare; U.S. Public Health Service, Centers for Disease Control, Atlanta Georgia.
- Pratt, H. D., F. Bjornson, and K. S. Littig. 1977. Control of Domestic Rats and Mice. U.S. Department of Health, Education, and Welfare; U.S. Public Health Service, Centers for Disease Control, Atlanta Georgia.
- Schultz, W. 1989. The Chemical-Free Lawn: The Newest Varieties and Techniques to Grow Lush, Hardy Grass. Rodale Press, Emmaus, Pennsylvania 18098.

Scott, H. G. and M. R. Boram. 1968. Rodent Borne Disease Control through Rodent Stoppage. U.S. Department of Health, Education, and Welfare; U.S. Public Health Service, Centers for Disease Control, Atlanta Georgia.

Simmons, S. E. 1985. Parklands Pest Management. California Department of Food and Agriculture, Sacramento, California.

Smith, E. H. and R. C. Whitman. 1992 and 1995 (Supplement I). NPCA Field Guide to Structural Pests, National Pest Management Association, Virginia.

Timm, R. M. 1994. House Mice. In: Hygnstrom, S. E., R. M. Timm, and G. E. Larson, Prevention and Control of Wildlife Damage. University of Nebraska Cooperative Extension and U.S. Department of Agricultural, APHIS.

Timm, R. M. and W. E. Howard. 1994. White-footed and Deer Mice. In: Hygnstrom, Scott E., R. M. Timm, and G. E. Larson, Prevention and Control of Wildlife Damage. University of Nebraska Cooperative Extension and U.S. Department of Agricultural, APHIS.

Truman, L. C., G. W. Bennett, and W. L. Butts. 1982. Scientific Guide to Pest Control Operations. Harcourt Brace Janovich, Inc.

U.S. Dept. of Interior, National Park Service. 1984, 1995. First and Second Editions, IPM Information Manual. Washington D.C.

U.S. Department of Interior, National Park Service, Public Health Program. 1997. Mechanical Rodent Proofing Techniques. By: G. Hoddenbach (consultant to NPS); J. Johnson (Chief of NPS Public Health); and C. DiSalvo (Integrated Pest Management, WASO).

Verrall, A.F. and T. Amburgey. 1975. Prevention and Control of Decay of Homes. U.S. Department of Agricultural and Department of Housing and Urban Development.

Vertebrate Pest Management: Category 7: A Guide for Commercial Applicators. Environmental Protection Agency. 1992.

Ware, G. W. 1988. Complete Guide to Pest Control - With and Without Chemicals. Thomson Publications, Fresno California 93791.

APPENDIX VIII

PRODUCT LABELS

THE FOLLOWING LOW-RISK PRODUCTS ARE SUGGESTED FOR USE AT
SAINT-GAUDENS NATIONAL HISTORIC SITE:

BoraCare Termiticide, Insecticide and Fungicide Concentrate
Borid
Conserve SC Turf and Ornamental
Drax Liquidator Ant Bait
EcoExempt IC Insecticide Concentrate
Flea 'n Tick B Gone
Hinder Deer & Rabbit Repellant
Jecta Diffusible Boracide
Matran 2 Non-Selective, Post Emergence Herbicide
Niban-FG Fine Granular Bait
NiBor-D Insecticide
Perma-Guard Commercial Insecticide
Perma-Guard Garden and Plant Insecticide
Perma-Guard Grain or Seed Storage Insecticide
TimBor Professional Insecticide and Fungicide
Tri-Die
Victor Poison-Free Wasp & Hornet Killer
WOODguard Exterior Wood Preservative and Finish
WOW (Without Weeds)

All of the above labels and material safety data sheets can be viewed separately in pdf format with the exception of Perma-Guard Garden and Plant Insecticide and WOW (which are in Word Perfect format).

APPENDIX IX

VENDORS

VENDORS

AGRIZAP, INC., 4535 McGrath Street, Building B, Ventura, CA 93003. 1-888-332-3728.
www.ratzapper.com. Electronic rodent management device.

BENEFICIAL INSECTARY, 9664 Tanqueray Court, Redding, CA 96003. 1-800-477-3715.
www.insectary.com. Provides beneficial critters for managing aphid, whitefly, mites and more.

BIOCONTROL NETWORK, 5116 Williamsburg Road, Brentwood, TN 37027. 1-800-441-2847. www.biconet.com. Provides an extensive list of low-risk pest control critters and products.

DO-IT-YOURSELF PEST CONTROL, INC., 2823 Chamblee-Tucker Road, Atlanta, GA 30341. 1-800-476-3368. www.doyourownpestcontrol.com. Provides Dekko Silverfish Paks (manufactured by Dekko Manufacturing, LLC) for control of silverfish and more.

GARDENS ALIVE!, 5100 Schenley Place, Lawrenceburg, IN 47025. 1-812-537-8650.
www.gardens-alive.com. Informative catalog with a wide selection of many biological-based pest controls, including beneficial predators, parasites, beneficial nematodes, fertilizers and much more.

INSECTS LIMITED, INC., 16950 Westfield Park Road, Westfield, IN 46074. 1-317-896-9300.
www.insectslimited.com Provides pheromone traps for museum, stored product and other pests.

IPM LABORATORIES, Main Street, Locke, NY 13092-0099. 1-315-497-2063.
www.ipmlabs.com. This company produces a very informative catalog and newsletter with helpful, expert information on using its many beneficial insects. Provides whitefly egg parasites and predators as well as a number of wasp parasites for aphid control, including the difficult to find *Aphelinus abdominalis* and *Aphidius ervi*. They always carry a quality product.

M&R DURANGO, INC., P.O. Box 886, Bayfield, CO 81122 aka The Good Bug Company, 970-259-3521. www.goodbug.com. Provides *Encarsia Formosa*, thrips predator, spider mite predator, green lacewing and more.

NEEM RESOURCES, THE AHIMSA ALTERNATIVE, INC., 5317 Whiting Avenue, Edina, MN 55439. 1-877-873-6336 or 1-405-538-0280. www.neemresource.com. Provides pure neem oil, karanja oil and other neem products for natural pest management.

PERMA-GUARD, INC., 625 East 2150 South, Bountiful, UT 84010. 1-877-801-2025.
www.perma-guard.com. Supplier of diatomaceous earth product and pyrethrin and diatomaceous earth insecticides.

PEST CONTROL SUPPLIES, 1700 Liberty Street, Kansas City, MO 64102. 1-800-821-5689.
www.pcspest.com. Termite and rodent control, herbicides, insect traps.

PRESERVATION PRODUCTS UNLIMITED, 6929 Seward Avenue, P.O. Box 29109, Lincoln, NE 68529. 1-800-648-7329.

RESIDEX, 8486-F Tyco Road, Vienna, VA 22182. 1-800-247-8528. www.residex.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

RINCON-VITOVA INSECTARIES, INC., P.O. Box 1555, Ventura, CA 93002. 1-800-248-2847. www.rinconvitova.com. Provides a wide variety of pest management supplies and beneficial organisms.

TARGET SPECIALTY PRODUCTS, 15415 Marquardt Avenue, Santa Fe Springs, CA 90670. 1-562-802-2238. www.target-specialty.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

UNIVAR USA. One Colonial Road (P.O. Box 730), Salem, MA 01970. 1-978-745-3700. www.univarusa.com. A source for pesticides, Lo-Line sticky monitoring traps, Victor snap traps and more.

VICTOR PEST AND SAFER PEST CONTROL PRODUCTS. 1-800-800-1819. www.victorpest.com. Provides a full line of poison-free and low-risk pest management products. There is a search feature on pests, what they are, what diseases they may carry, and how to prevent infestations.

NOTE:

These suppliers are known to IPMI as providing high-quality products and services. There are hundreds of pest management product suppliers in the U.S. that may also provide high-quality products and services.

- Victor brand snap traps are the oldest manufactured traps, are widely available, and can be easily “fine-tuned” for reliable kills.
- Lo-Line monitoring (sticky) traps for crawling insects are the best designed, reliable products on the market to date.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-43 October 2006

ON THE BACK COVER

Aspet in winter, Augustus Saint-Gaudens' residence and thornless honey locust tree which he planted in 1886
Photograph by: Jean A. Currie, President, International Pest Management Institute

National Park Service
U.S. Department of the Interior



Northeast Region
Natural Resource Stewardship and Science
15 State Street
Boston, Massachusetts 02109

<http://www.nps.gov/nero/science/>



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